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. Leath and Lowell D. Hill

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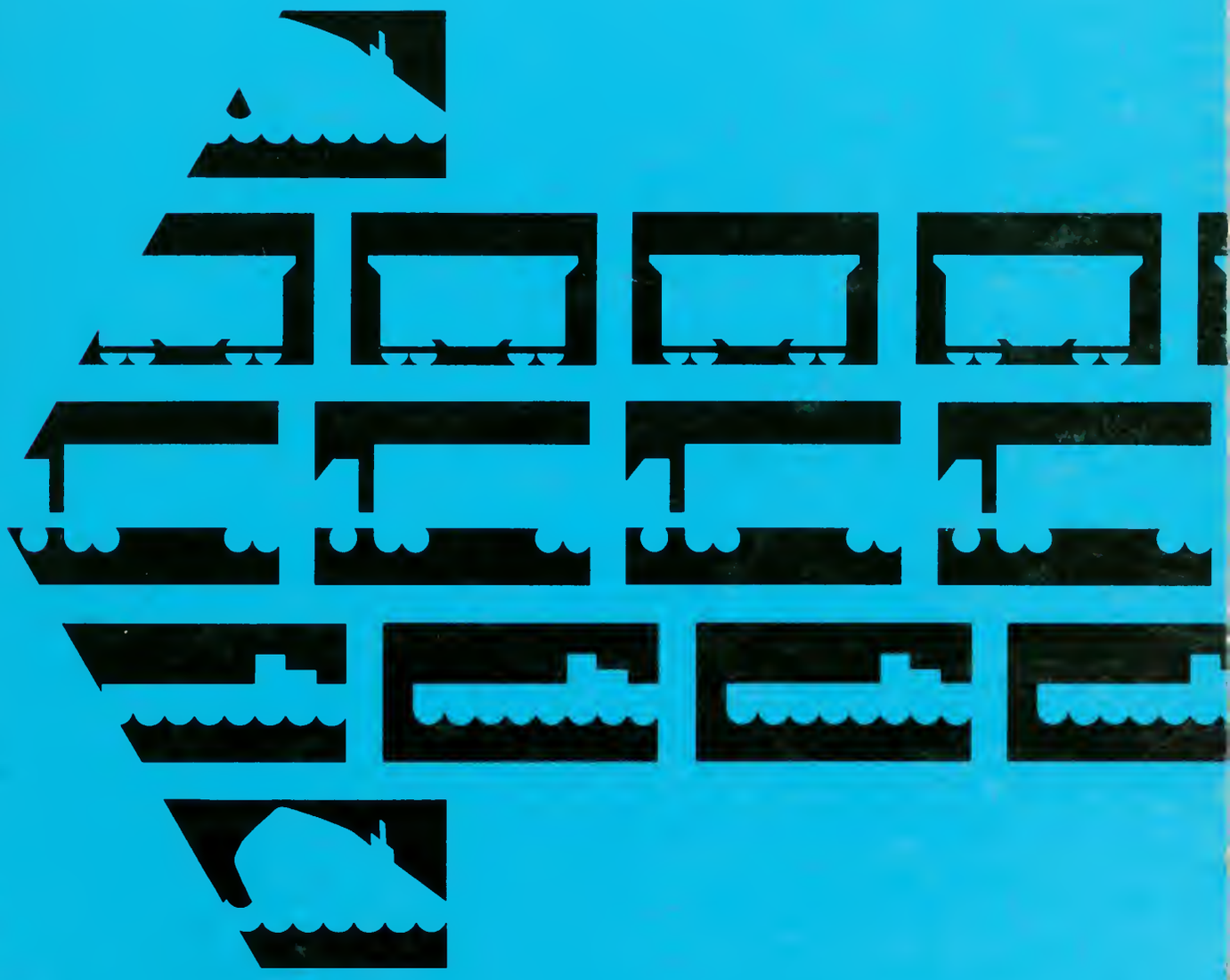

ABSTRACT

The marketing of grain in the U.S. involves complex interregional movements. Moving each grain from the area of concentrated production to points where it is used or exported requires a large transportation capacity. To provide a basis for policy and investment decisions, detailed information on grain movements during 1977 was collected from 3,500 grain merchandising, processing, and exporting firms in 41 states. Information on the origin, destination, and mode of transport used was collected for barley, corn, flaxseed, oats, rye, sorghum, soybeans, and wheat in each participating state. Survey data on receipts and shipments for each state were expanded and reconciled with similar data for other states to determine the overall marketing pattern for each grain. These results were compared with data from secondary sources to evaluate trends in U.S. grain marketing patterns during the 1970s. The marketing patterns for individual grains and the transportation requirements for all grain movements are presented and summarized in this bulletin.

Keywords: Grain flows, grain shipping, grain transportation, grain marketing, barley, corn, flaxseed, oats, rye, sorghum, soybeans, wheat.

Grain Movements, Transportation Requirements, and Trends in United States Grain Marketing Patterns During the 1970s

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Preface

The research reported in this bulletin is the first effort ever made to survey grain shippers and receivers nationwide; it is the most comprehensive study of grain movements ever conducted. Members of the technical committees, including representatives of Agricultural Experiment Stations in 25 states, assisted in conducting an industry survey to collect flow data for wheat, corn, soybeans, sorghum, oats, barley, and rye. In addition, surveys were conducted in 16 other states through contracts with 15 universities located in those states. The industry surveys were coordinated by Lowell D. Hill, Department of Agricultural Economics, University of Illinois at Urbana-Champaign. The data were tabulated and summarized under the supervision of Mack N. Leath, Economic Research Service, U.S. Department of Agriculture. The success of this research project is due to the cooperation of thousands of grain marketing firms and the efforts of researchers in the many participating states.

The research was funded in part through contract DACW 72-78-C-0005 with the Institute of Water Resources, U.S. Army Corps of Engineers. Supplemental support was provided by the Federal Railroad Administration of the U.S. Department of Transportation, the Maritime Administration of the U.S. Department of Commerce, and the St. Lawrence Seaway Development Corporation. Administration of grant funds was coordinated by Lowell D. Hill, University of Illinois at Urbana-Champaign.

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Introduction

Moving grain from the areas where it is produced to the many locations where it is processed, consumed, and exported gives rise to a large demand for transportation. The volume of grain that must be transported in the United States is large because the production of the various grains is highly concentrated in certain geographical areas and because a large proportion of the grain is channeled to port regions for export to overseas destinations. For all crops except wheat, ten or fewer states account for 80 percent or more of the total annual production. Although many ports participate in grain exports, a large proportion (about 60 percent) of the volume exported is channeled through ports located on the Gulf of Mexico.

Information about the origin and destination of grain movements and about the modes of conveyance used to transport grain is important for many policy and investment decisions. Although statistics on the volume of grain shipped on the inland waterways are published periodically, little information has been available that could be used to match origins with destinations and to identify the proportion of total movements transported by the competing modes of transportation.

Recognition of the need for better information in this area led to a nationwide survey of grain shippers and receivers. Over 3,500 grain merchandisers, processors, and exporters throughout the United States were contacted in 1978. Through personal interviews, data on origins, destinations, and trnsportation modes were collected for wheat, soybeans, corn, sorghum, oats, barley, rye, and flaxseed. Detailed information on the movements of each commodity has been published in regional bulletins (*4, 5, 7, 8, 9, 10*).* In addition, several states have published reports pertaining to grain movements. A bibliography of those reports is included at the end of this bulletin. This publication summarizes the flow patterns for all grains in a form that will be useful to executives and policy makers who do not need detailed data. In addition, changes that occurred in distribution patterns during the 1970s will be discussed.

* Italicized numbers in parentheses refer to the list of references at the end of this bulletin.

Purpose of Study

Analysis of grain flow patterns can reveal the geographical nature of grain markets and the types of transportation services required by the grain industry. This information is useful to grain firms in identifying additional marketing opportunities and in making decisions about where to locate new handling, storage, and processing facilities.

Of equal importance is the value of this information to those who set federal and state transportation policies. The formulation of rational grain transportation policies depends upon knowledge of existing grain flows and associated transportation modes. In many situations, firms or public agencies make decisions affecting the production, storage, and transportation of grain without adequate information about grain distribution patterns and the demands that those decisions will place on the various transportation modes. The objectives of this study were:

1. To determine the volume of grain moving between various origins and destinations
2. To determine the extent to which the various transportation modes are employed in the movement of grain in the United States.

Methodology

For the purposes of this study, the United States was divided into 132 numbered regions and 31 ports, as shown in Figure 1. Data for the 31 ports were aggregated into 13 port areas located in four major export regions. The specific ports included in each port area are listed with their identifying numbers in Table 1.

Grain flow data were collected for the 1977 calendar year primarily through personal interviews with representatives of grain handling, storage, and processing firms in 41 states. The firms from which data were obtained included country elevators, inland terminal elevators, river terminal elevators, feed manufacturers, export elevators, commercial feedlots, and processors. A representative from each state's Agricultural Experiment Station was responsible for drawing the sample and conducting the interviews.

The sampling of inland grain elevators in each state was carried out by listing the elevators in descending order of storage capacity. Starting with the largest, elevators were added to the sample until the total of their storage capacities was equal to at least 25 percent of the inland elevator storage capacity in that state. Not less than 10 percent of the remaining elevators were then selected at random. For river elevators the procedure was simpler: a minimum of 50 percent of the

Figure 1. Location of grain flow study regions.

elevators were selected by random sampling.

Feed manufacturing firms in each state were arrayed on the basis of their production capacity. Starting with the largest, feed firms on the list were added to the sample until the total of their production capacities equalled or exceeded 10 percent of the total feed manufacturing capacity in the state. Ten percent or more of the remaining firms were then selected at random and included in the sample. All exporters and processors were included in the interviews.* Data based on random samples were expanded in proportion to the sampling rate to convert the data into estimates for the entire region or state.

The same types of information were gathered from all of the grain handlers and processors interviewed. The firms were asked to identify the volume of each grain received from each region and the volume received by each mode of transportation. They were also asked to identify each region or port area for which their shipments were destined and the quantity shipped by each mode.

Agricultural Experiment Station representatives verified the accuracy of the data collected, expanded the sample data to state totals, and delivered the summary data for each grain and for every substate region to the U.S. Department of Agriculture for processing. As receivers' and shippers' data were tabulated, the Experiment Station representative in each state checked any discrepancies to identify potential data errors and to arrive at a single number for each origin-destination pair. Insofar as possible, the state representatives checked the data for each shipment to ascertain that they were consistent and logical.

* Only one major processor did not provide data for the study. Data on receipts by that firm were estimated from information furnished by shippers.

Verification of Data

The accuracy of the data on the volume of each grain shipped between the various origins and destinations by each mode of transportation was verified by several direct and indirect comparisons with data from other sources. One indirect check was made by totaling interstate and export shipments and subtracting from that value the total of interstate receipts for each state to determine how closely the results

greed with the surplus or deficit alculated for the state.* Exact correspondence was not expected since he quantities used for livestock feed nd shipped to processors were estimated rather than determined rom actual consumption data. Any najor discrepancies, however, were nvestigated to verify that they did iot indicate significant errors in the urvey data.

A second check on total volume vas made by comparing total receipts at each port with official data on inspections for export as published by the Market News Service of the U.S. Department of Agriculture. Because there were few opportunities for either set of data to miss significant volumes, these numbers compared very closely. Discrepancies between receipts and exports at the port areas were explained, in most cases, by shipments to domestic destinations from export elevators, shipments to processing plants located in the port area, and changes in inventory between the beginning and end of the year.

Supplemental information about grain shipments on inland waterways was provided by the U.S. Army Corps of Engineers. Since these data were based on the actual bill of lading for each shipment, they were, in principle, a complete census of all barge shipments. The survey data and the Corps of Engineers data on state-to-state shipments on inland waterways corresponded closely for most states. Differences between the two sets of data usually could be explained by (1) a significant number of shipments for which the origins and destinations are noted as "unknown" in the Corps data, (2) changes in the destination of barges after they left the loading dock, (3) incomplete reportings of loadings to the Corps of Engineers, and (4) errors in reporting by survey respondents. The most notable differences occurred in Idaho, Washington, and Oregon, where barge movements on the Snake-Columbia River system were seriously understated in the Corps of Engineers data.

The last method of validation provided important insight into U.S. Department of Transportation data based on a 1 percent sample of all rail bills of lading. These data were expanded to develop estimates of annual shipments and receipts in each state and then compared with the rail shipments reported by survey respondents. Some similarities were apparent, but there were also many major differences. These discrepancies appeared to be greatest for cases where unit trains and multiple-car shipments accounted for a large share of the movements between states, and they appeared to be smallest where single-car shipments predominated. Additional analysis of both data sets led to the conclusion that there were serious sampling errors in the 1 percent waybill statistics and that those data should therefore be used with caution, especially where grain commonly moves in multiple-car units. Although the volume of grain shipments indicated by the two data sets differ substantially in many instances, the data sets agreed closely on the destinations to which the grain was moving.

The comparisons between various data sources increase the confidence in the accuracy of estimates derived from sampling a less than perfectly identified population. The logic of the movements reported in this bulletin has been checked by the university person that organized the survey in each state. Where internal inconsistencies were found, the data and the sampling rates were adjusted with assistance from grain specialists and industry personnel in the state. The flow estimates presented in the following sections represent the best information available on the actual volume of grain transported between the regions of the U.S. in 1977.

Table 1. Export Regions, Port Areas, and the Ports Included in Each Area

Export region and port area[a]	Ports included
Great Lakes Region	
Duluth-Superior	Duluth, MN
	Superior, WI
Chicago	Chicago, IL
	Manitowoc, WI
	Racine, WI
	Chicago, IL
Toledo	Toledo, OH
	Huron, OH
	Erie, PA
	Buffalo, NY
Saginaw	Carrollton, MI
	Saginaw, MI
	Zilwaukee, MI
	Detroit, MI
Atlantic Region	
North Atlantic	Portland, ME
	Albany, NY
	Philadelphia, PA
South Atlantic	Baltimore, MD
	Norfolk, VA
	North Charleston, SC
Gulf Region	
East Gulf	Pascagoula, MS
	Mobile, AL
Louisiana Gulf	Mississippi River
	Lake Charles, LA
North Texas Gulf	Beaumont, TX
	Port Arthur, TX
	Houston, TX
	Galveston, TX
South Texas Gulf	Brownsville, TX
	Corpus Christi, TX
Pacific Region	
Columbia River	Kalama, WA
	Longview, WA
	Vancouver, WA
	Portland, OR
	Astoria, OR
Puget Sound	Seattle, WA
	Tacoma, WA
California Ports	Sacramento, CA
	Stockton, CA
	Long Beach, CA
	San Francisco, CA

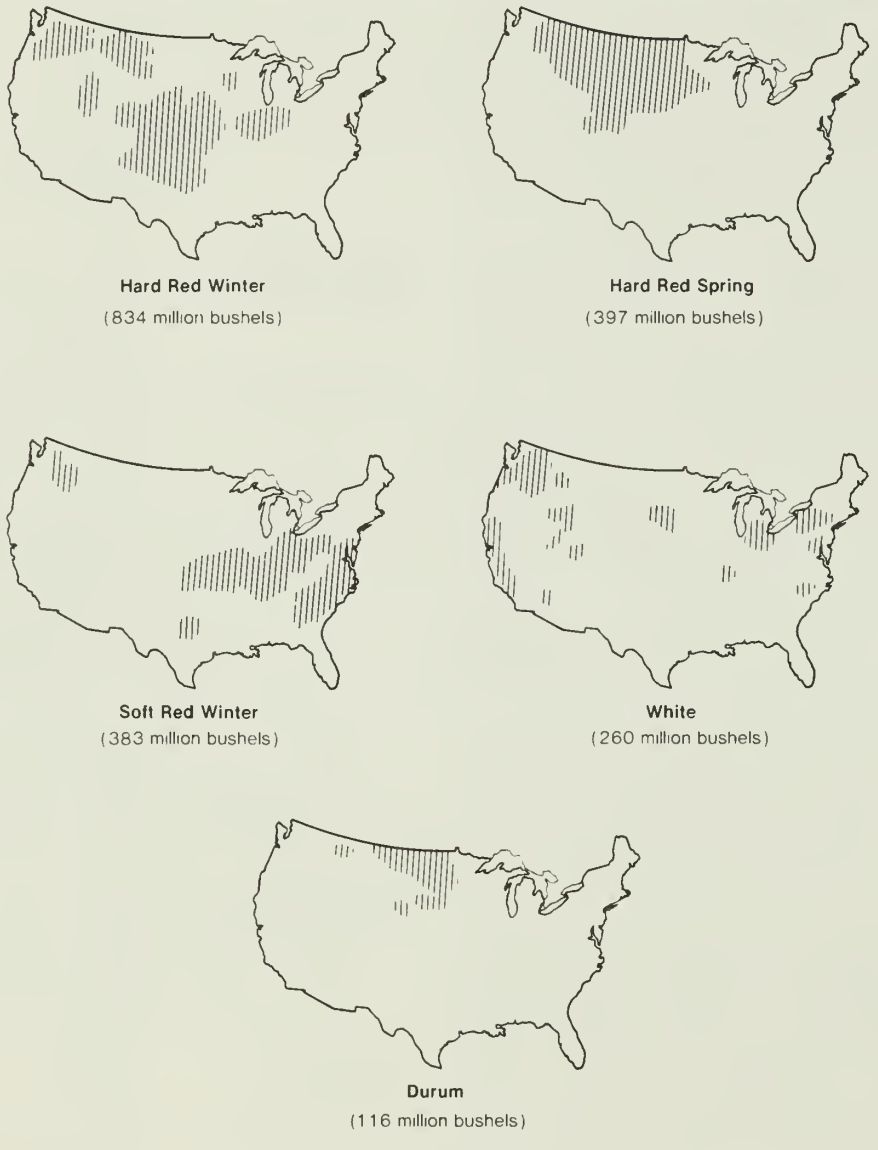
[a] These port areas will be used in this report to avoid disclosure of data from individual firms.

The surplus or deficit for each state was alculated by adding the 1977 production o the stocks in all positions as of January , 1977, then subtracting the estimated mount used for livestock feed, processing, nd seed and deducting the stocks in all ositions as of January 1, 1978.

Wheat Marketing Patterns

The volume of wheat that must be transported is large because production of the various classes of wheat is highly concentrated in certain geographical areas, and the grain must be dispersed for use throughout the U.S. Also, the very large export demand necessitates shipping wheat to all of the nation's port regions. The production of wheat is concentrated in the Great Plains, where rainfall is usually inadequate for corn and soybean production. The leading wheat-producing states are Kansas, North Dakota, Oklahoma, Minnesota, and Montana. In 1977, these five states produced slightly more than 1 billion bushels of wheat, half of the total U.S. production (Table 2).

Figure 2. Locations in which various kinds of wheat are grown in the United States. The average amount of each type produced in 1976-1978 is given in parentheses.



The data on interstate movements may be used in conjunction with published inventory and production data to estimate the amount of wheat used in various states. These estimates are shown in Table 2, where net use is measured as a residual. The negative net-use estimates in North Dakota and South Dakota indicate that either interstate shipments were overestimated or data on stocks and production contained estimation errors. The total net use estimate for the U.S. is in close agreement with published utilization figures when the total is adjusted for exports of flour and other processed wheat products. Export shipments shown in Table 2 exclude product exports, which were equivalent to about 50 million bushels of wheat in 1977. About two-thirds of the wheat used in the U.S. is consumed in foods for humans. The balance is used as seed and as feed for livestock.

Factors that Influence Marketing Patterns

Flow patterns for wheat are more complex than those for other grains because different classes of wheat are grown in different parts of the nation. The classes of wheat that can be grown successfully in an area are determined by the climate, soil type, amount of rainfall, and the use of irrigation. The production of hard red winter wheat is concentrated in the central and southern plains states. That class of wheat accounted for 42 percent of U.S. production in 1976–1978 (Figure 2). About 20 percent of all wheat produced during that period was of the hard red spring class, which is grown in Minnesota, Montana, North Dakota, and South Dakota. Soft red winter wheat, which also comprised about 20 percent of the total in 1976–1978, is grown primarily in states east of the Missis-

ippi River. Illinois, Indiana, and Ohio are the principal producing tates. White wheat production is oncentrated in the Pacific Northvest, but a relatively small amount s grown in Michigan. Durum is a pecialty class of wheat, the proluction of which is concentrated in North Dakota.

Each class of wheat is segregated during storage and transportation. Millers and exporters purchase the class with the quality characteristics that meet their needs. Wheats of the hard type tend to be higher in protein content; their principal domestic use is in the production of bread flour. The soft wheats, which are lower in protein, are milled into flour for cakes, cookies, pastries, and crackers. The durum varieties are used mainly in the production of semolina, a granular type of flour used to make pasta products.

Flour mills operating in the United States are generally classified as hard-wheat mills, soft-wheat mills,

Table 2. Supply and Utilization of Wheat by State in 1977

State	Beginning stocks	Production	Interstate receipts[a]	Total available	Interstate shipments[a]	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama	1.6	3.1	11.3	16.0	0.7	5.0	1.2	9.1
Arizona	4.7	10.1	1.7	16.5	4.5	0.0	3.1	8.9
Arkansas	2.5	25.7	1.9	30.1	18.4	0.0	4.1	7.6
California	23.5	42.5	23.9	89.9	0.2	13.1	16.6	60.0
Colorado	44.7	57.4	3.9	106.0	19.8	0.0	60.6	25.6
Delaware	0.5	0.9	1.0	2.4	1.9	0.0	0.5	0.0
Florida	0.5	0.4	7.8	8.7	0.3	0.0	0.2	8.2
Georgia	1.1	3.3	1.9	6.3	0.3	0.0	0.9	5.1
Idaho	45.0	57.9	9.3	112.2	47.8	0.0	37.2	27.2
Illinois	40.6	67.5	34.9	143.0	57.1	2.6	51.4	31.9
Indiana	16.7	55.8	13.8	86.3	54.9	0.0	18.1	13.3
Iowa	3.9	4.0	4.2	12.1	4.4	0.0	3.1	4.6
Kansas	371.2	344.8	28.1	744.1	242.0	0.0	390.7	111.4
Kentucky	4.7	10.1	2.4	17.2	10.3	0.0	4.3	2.6
Louisiana	6.3	1.3	175.5	183.1	3.8	162.2	9.9	7.2
Maryland	1.3	3.6	15.6	20.5	3.8	13.0	1.0	2.7
Michigan	20.6	33.0	.6	54.2	13.0	2.4	26.1	12.7
Minnesota	103.8	131.9	234.9	470.6	149.3	88.8	146.2	86.3
Mississippi	.6	3.6	8.2	12.4	3.9	7.5	0.3	0.7
Missouri	49.9	72.2	52.8	174.9	66.2	0.0	46.9	61.8
Montana	138.8	130.9	0.0	269.7	76.8	0.0	148.8	44.1
Nebraska	95.1	103.2	11.1	209.4	59.3	0.0	115,1	35.0
Nevada	.7	1.4	0.0	2.1	0.3	0.0	0.5	1.3
New Jersey	1.1	1.2	0.0	2.3	0.4	0.0	0.7	1.2
New Mexico	3.5	9.1	0.0	12.6	2.7	0.0	5.2	4.7
New York	19.8	6.8	77.7[b]	104.3	0.3	10.5	24.3	69.2
North Carolina	3.6	6.0	7.4	17.0	1.6	0.0	2.7	12.7
North Dakota	263.1	229.9	0.0	493.0	212.8	0.0	293.6	−13.4
Ohio	42.6	72.4	18.8	133.8	31.7	14.9	50.8	36.4
Oklahoma	126.3	175.5	33.2	335.0	133.9	0.0	141.2	59.9
Oregon	47.1	47.6	102.8	197.5	36.7	100.3	38.4	22.1
Pennsylvania	6.2	8.1	21.2	35.5	0.1	0.9	7.4	27.1
South Carolina	0.3	2.5	1.4	4.2	0.3	0.1	0.8	3.0
South Dakota	40.8	72.0	0.1	112.9	44.2	0.0	74.2	−5.5
Tennessee	5.9	10.1	32.9	48.9	12.6	0.0	6.7	29.6
Texas	98.3	117.5	309.2	525.0	15.4	303.0	138.3	68.3
Utah	9.1	5.7	4.9	19.7	3.4	0.0	7.1	9.2
Virginia	2.4	6.2	15.2	23.8	0.8	7.5	3.6	11.9
Washington	117.7	101.3	139.9	358.9	67.9	159.1	97.1	34.8
West Virginia	0.2	0.3	0.0	0.5	0.0	0.0	0.2	0.3
Wisconsin	10.8	3.1	0.1	14.0	2.6	0.2	10.7	0.5
Wyoming	4.7	5.6	0.2	10.5	2.1	0.0	4.0	4.4
Total volume	1,781.8	2,045.5	1,409.8[b]	5,237.1	1,408.5	891.1	1,993.8	943.7

Sources: (*10, 16, 17*).

[a] Includes interstate movements by farm trucks as reported by elevator operators.

[b] Includes 1.3 million bushels imported from Canada.

and durum mills. In 1978, 265 flour mills were active. Their daily capacity was 1.1 million hundredweights, two-thirds of which was classified as hard-wheat milling capacity. These mills grind hard red winter wheat, hard red spring wheat, or a blend of these classes. About 25 percent of the mills by capacity were classified as soft-wheat mills, which generally use either soft red winter or white wheats. About 7 percent of the capacity was devoted to durum wheat.

In the past, flour mills were generally located in the areas that produced the type of wheat they used. The flour produced was transported to the points of consumption. In some instances mills were located away from the source of supply when economical transportation was available for the type of wheat required. For example, the hard-wheat milling centers at Buffalo, New York, and Chattanooga, Tennessee, developed because water transportation was available to move hard wheat to those locations.

In recent years, large hard-wheat mills have been constructed near major flour consumption points. Examples are the large hard-wheat mills in Florida, Louisiana, and Virginia. In 1978, 30 percent of the hard-wheat milling capacity was located in states east of the Mississippi River where only soft wheat was grown. Another 10 percent of the hard wheat capacity was located in the Pacific region. This recent practice of locating flour mills away from the areas that produce the class of wheat they use has given rise to sizable interregional movements of wheat.

The nature of the export demand for wheat also results in complex interregional movements. Almost all of the wheat exported from the U.S. is sold under contracts specifying a certain class of wheat. Consequently, exporters must procure supplies in the region where the desired class of wheat is produced and transport those quantities to a port area. In 1977, wheat exports totaled 891 million bushels, or 49 percent of the total disappearance. About 60 percent of the total volume exported was of either the hard red winter or hard red spring classes, which are produced in the Great Plains.

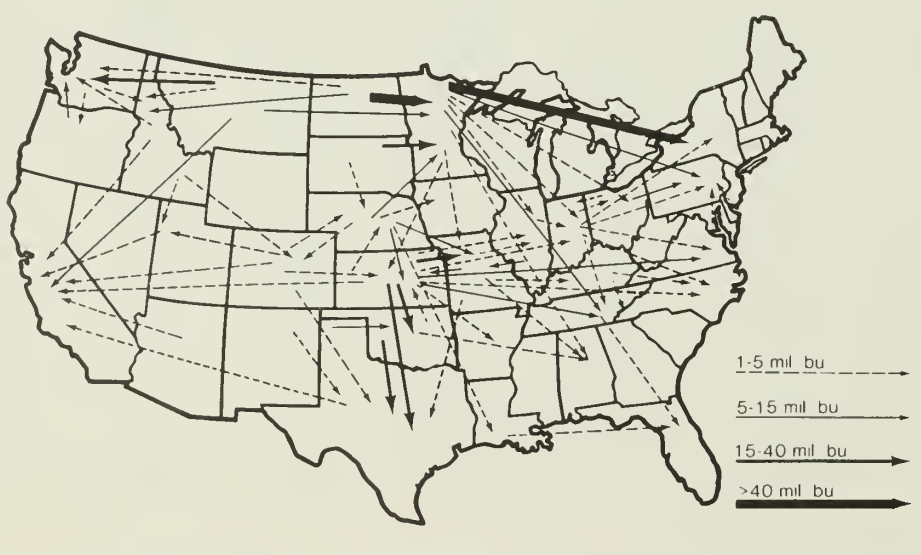
Shipments by State

Grain marketing firms in the United States reported shipping 2.5 billion bushels of wheat in 1977 (Table 3), excluding the 891 million bushels that were shipped to overseas destinations by port elevators. A sizable portion of that total is accounted for by the wheat being shipped in sequence by several firms. For example, over 63 million bushels that were shipped to port elevators at Duluth-Superior were reshipped to other destinations. Several terminal markets such as those at Enid, Kansas City, Minneapolis, Omaha, and Wichita serve as major storage and transshipment points for wheat, and flour millers located outside the major production regions rely on these markets for their supply.

The total volume shipped by all firms exceeded total disappearance in 1977 by almost 700 million bushels. It seems reasonable to assume that a large portion of that quantity was received and reshipped by terminal and river elevators and that the balance represented inventory increases at inland and port terminals. Heid reported that terminal elevators handled 606 million bushels during the 1977–78 marketing year (*1*). Total receipts from farmers by all firms were 1,739 million bushels, approximately equal to off-farm sales.

Shipments to domestic destinations within the originating state accounted for 897 million bushels, or 35 percent of the total. Firms in Kansas shipped 225 million bushels to destinations within the state, considerably more than in any other state. Shipments among firms in Oklahoma totaled 124 million bushels. Intrastate movements in Texas and Washington exceeded 130 million bushels in 1977, but a majority of the movements in Washington were to export points in the Columbia River and Puget Sound areas. Intrastate movements in Minnesota exceeded 125 million bushels in 1977. Of that total, 92 million bushels moved to domestic rather than export points, Minneapolis being the predominant destination.

Figure 3. Pattern of wheat flows to domestic destinations in 1977.



Interstate shipments of wheat to domestic points totaled 562 million bushels in 1977 (Table 3). This volume consisted of movements to terminal elevators and flour mills in other states. Kansas and North Dakota firms originated 194 million bushels, or almost 35 percent of the total. Firms in five other states (Minnesota, Montana, Nebraska, Oklahoma, and South Dakota) shipped more than 30 million bushels to interstate domestic destinations. All of these states are important producers of the hard classes of wheat. Figure 3 illustrates the pattern of interstate domestic movements.

Shipments to export regions (ports) in 1977 exceeded 1 billion bushels, or 42 percent of the total volume shipped (Table 3). A portion of the wheat shipped to several of the ports, however, was reshipped to other ports or domestic destinations. Firms in Washington shipped 156 million bushels to port areas, more than any other state. North Dakota, Kansas, and Oklahoma each shipped more than 100 million bushels to export regions. Together, these four states shipped 49 percent of the total volume of wheat that moved to port destinations in 1977. Figure 4 shows the pattern of these movements.

Wheat movements to export regions from each state are summarized in Table 4. Ports located on the Gulf of Mexico were the destinations of 504 million bushels, or 47 percent of the total volume shipped to port areas. Kansas, Oklahoma, and Texas firms shipped over 300 million bushels of hard red winter wheat to the Gulf region, and most of the shipments were destined for Texas ports. Louisiana port facilities exported over 90 million bushels of soft red winter wheat in 1977. Much of this wheat came from Illinois and Arkansas. Sizable quantities of hard red spring and durum wheats were shipped to these ports from Minnesota. Missouri was the predominant origin of hard red

Table 3. 1977 Shipments of Wheat to Domestic Destinations and Export Regions by Marketing Firms in Each Originating State or Port Area

Originating state or port area	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the state	In other states		
	thousands of bushels			
States				
Alabama	1,054	628	1,511	3,193
Arizona	4,388	2,701	1,744	8,833
Arkansas	9,876	1,667	13,266	24,809
California	13,539	0	1,085	14,624
Colorado	6,430	14,166	5,338	25,934
Delaware	113	1,732	136	1,981
Florida	3,500	0	259	3,759
Georgia	330	279	0	609
Idaho	13,687	8,799	38,728	61,214
Illinois	45,703	10,669	43,339	99,711
Indiana	27,764	14,666	37,648	80,078
Iowa	1,271	2,423	1,553	5,247
Kansas	225,106	116,470	125,104	466,680
Kentucky	1,578	6,071	3,733	11,382
Louisiana	271	288	1,263	1,822
Maryland	185	2,756	60	3,001
Michigan	13,199	647	10,715	24,561
Minnesota	92,347	35,063	83,703	211,113
Mississippi	656	744	3,218	4,618
Missouri	35,154	19,366	42,650	97,170
Montana	17,403	33,514	43,277	94,194
Nebraska	78,774	35,477	23,650	137,901
Nevada	0	193	113	306
New Jersey	0	350	0	350
New Mexico	0	2,380	311	2,691
New York	3,828	346	50	4,224
North Carolina	3,944	462	865	5,271
North Dakota	7,444	77,329	134,939	219,712
Ohio	31,852	12,651	26,438	70,941
Oklahoma	123,664	31,483	102,421	257,568
Oregon	12,176	5,483	50,000	67,659
Pennsylvania	2,959	82	0	3,041
South Carolina	834	293	105	1,232
South Dakota	2	32,092	10,917	43,011
Tennessee	7,155	5,821	6,821	19,797
Texas	61,891	15,449	74,590	151,930
Utah	6,149	2,950	489	9,588
Virginia	806	762	1,372	2,940
Washington	39,042	2,554	156,495	198,091
Wisconsin	89	315	2,491	2,895
Wyoming	66	650	1,406	2,122
Port Areas				
Duluth-Superior	7	58,519	4,786	63,312
Chicago	1,091	0	3,015	4,106
Toledo	908	0	3,967	4,875
South Atlantic	818	0	0	818
Louisiana Gulf	0	3,500	0	3,500
Columbia River	0	387	0	387
Puget Sound	0	0	1,082	1,082
Total volume	897,053	562,177	1,064,653	2,523,883
Percentage of total volume	35.6	22.3	42.1	100.0

Note: The data in this table exclude export elevator shipments to foreign destinations by water.

Table 4. 1977 Movements of Wheat to Export Regions from Individual States and Port Areas

Originating state or port area	Export region				Total
	Great Lakes	Atlantic Coast	Gulf Coast	Pacific Coast	
	thousands of bushels				
States					
Alabama	0	0	1,511	0	1,511
Arizona	0	0	0	1,744	1,744
Arkansas	0	0	13,266	0	13,266
California	0	0	0	10,989	10,989
Colorado	0	0	886	4,452	5,338
Delaware	0	136	0	0	136
Florida	0	0	259	0	259
Idaho	0	0	0	38,728	38,728
Illinois	2,197	330	40,812	0	43,339
Indiana	12,535	17,885	7,409	0	37,829
Iowa	0	0	1,553	0	1,553
Kansas	0	0	124,410	694	125,104
Kentucky	0	0	3,733	0	3,733
Louisiana	0	0	1,263	0	1,263
Maryland	0	81	0	0	81
Michigan	9,202	2,611	0	0	11,813
Minnesota	33,909	0	49,794	0	83,703
Mississippi	0	0	3,218	0	3,218
Missouri	0	0	42,650	0	42,650
Montana	2,083	0	0	41,194	43,277
Nebraska	3,001	0	19,243	1,406	23,650
Nevada	0	0	0	113	113
New Mexico	0	0	311	0	311
New York	0	50	0	0	50
North Carolina	0	865	0	0	865
North Dakota	109,514	0	400	25,025	134,939
Ohio	14,577	9,459	3,170	0	27,206
Oklahoma	0	0	102,421	0	102,421
Oregon	0	0	0	50,000	50,000
South Carolina	0	123	0	0	123
South Dakota	7,621	0	351	2,945	10,917
Tennessee	0	0	6,821	0	6,821
Texas	0	0	73,906	0	73,906
Utah	0	0	0	489	489
Virginia	0	1,372	0	0	1,372
Washington	0	0	0	156,495	156,495
Wisconsin	2,732	0	0	0	2,732
Wyoming	0	0	0	1,406	1,406
Port Areas					
Duluth-Superior	113	601	4,072	0	4,786
Chicago-Milwaukee	578	0	2,437	0	3,015
Toledo	0	3,967	0	0	3,967
Puget Sound	0	0	0	1,082	1,082
Total volume	198,062	37,480	503,896	336,762	1,076,200
Percentage of total volume	18.4	3.5	46.8	31.3	100.0

Note: The data in this table includes shipments that moved directly to port elevators from farms. Those shipments are excluded from Table 3.

winter wheat shipped to Louisiana ports.

Pacific Coast ports reported receipts of 337 million bushels in 1977 (Table 4.) Washington firms originated over 46 percent of that total. Idaho, Montana, North Dakota, and Oregon were also major sources of the wheat moving to the Pacific Northwest ports. White wheat was the predominant class exported from Pacific Coast ports; however, large quantities of hard red winter and hard red spring wheat were also exported from those areas.

Receipts at Great Lakes ports totaled 198 million bushels in 1977. Firms at Duluth-Superior handled the heaviest volume, with receipts totaling 152 million bushels. About 60 percent of the wheat received at that port area was exported, and the balance was reshipped to firms at other domestic locations. A majority of those reshipments moved to flour mills at Buffalo via the Great Lakes. Hard red spring and durum wheats were the primary classes handled by Duluth-Superior ports. These wheats were shipped to the port area from Minnesota and North Dakota. The other Great Lakes ports handled predominantly soft red winter wheat drawn from adjacent production regions.

About 96 percent of the wheat exported from Atlantic Coast ports in 1977 was of the soft red winter class. Indiana, Michigan, and Ohio were the principal origins for wheat moving to those ports. About 50 percent of the volume shipped from Michigan to Atlantic Coast ports consisted of white wheat.

Receipts at Domestic Destinations and Port Areas

In 1977, firms at various domestic destinations reported receipts of 590 million bushels of wheat from other states (Table 5). This total exceeds the shipments reported in Table 3

Figure 4. Pattern of wheat flows to port areas in 1977.

To the extent that firms purchased wheat from farmers in adjacent states. Minnesota led all states in terms of wheat received from other states, with interstate receipts totaling 116 million bushels. Minnesota terminals and flour mills received over 100 million bushels from North Dakota and South Dakota. Texas firms reported receipts of 66 million bushels. New York and Missouri received the next largest volume; interstate receipts in each of those states exceeded 50 million bushels. A majority of the wheat received in New York came from Minnesota by barge or laker vessel, whereas the greater share of wheat received in Missouri was shipped by rail.

More than half of the wheat that moved across state lines (56 percent of total receipts) was transported by rail. Trucks hauled 25 percent of the total, and barges carried 15 percent. The balance (4 percent) was moved by farm trucks. Most of the interstate receipts by firms in Alabama, Louisiana, New York, and Tennessee were transported by barge. The major flour mills in each of these states have access to barge transportation.

The importance of the export market to the U.S. wheat industry is demonstrated by the fact that almost 1.1 million bushels moved to various port areas in 1977 (Table 6). The predominant port area was the North Texas Gulf, which handled 26 percent of the total volume received at ports in 1977. The Columbia River port area ranked a close second in terms of volume. The Duluth-Superior port area ranked third; however, over 58 million bushels of its receipts were reshipped to domestic destinations.

There was great diversity in the modes of transportation used to convey wheat to the various ports. The Texas ports were served primarily by rail, whereas the other Gulf ports relied on barge movements for a majority of their receipts. Firms in the Duluth-Superior area relied on rail shipments from the northern plains states, but other Great Lakes ports satisfied most of their needs with grain brought by truck from nearby sources. The dominance of the Columbia River port area in the Pacific region is due in part to the availability of barge transportation. In 1977, 54 percent of the wheat received was transported by barge. In contrast to other port locations, 71 percent of the receipts at California ports moved directly from California farms.

Changes in the Pattern of Domestic Flows

Marketing patterns are constantly changing as sellers attempt to take advantage of profitable marketing opportunities. Likewise, millers and exporters continuously seek the most economical source of wheat that possesses the characteristics they desire. The areas of the nation in which the various classes of wheat are produced are determined by climate rather than economic factors and therefore do not change. Most of the changes that occur in wheat flow patterns are thus the result of transportation and demand factors. Changes in the relationship between rates for transporting wheat and flour affect the optimum location of flour mills. Shifts in regional demands for alternative types of flour influence the type of wheat milled at a particular location. Year-to-year variations in the quality of wheat grown at different locations affect the wheat blends processed by millers. The influence of crop quality on flows tends to be of short duration, whereas changes in response to transportation and demand factors tend to occur more slowly and are more lasting in nature.

The eastern Corn Belt states — Illinois, Indiana, and Ohio — are the leading states in the production of soft red winter wheat, and these states annually account for almost three-fifths of total U.S. production of that class of wheat. The southern states also produce soft red winter wheat; however, annual use exceeds production, and part of the demand in those states is satisfied with acquisitions from Corn Belt sources. Flour millers in the South also use hard red winter and hard red spring wheats, which must be shipped in from hard wheat production regions.

Comparing flow patterns at different points in time can reveal these long-term trends. A comparison of the 1977 flows with selected results from a 1970 survey of shippers and receivers in three eastern Corn Belt and eight southern states reveals some dramatic changes.

Table 5. Volume of Wheat Received in Various States from Origins Outside the State and Percentage Carried by Each Mode of Transportation in 1977

Destination state	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Alabama	7,578	15.1	6.8	78.1	0.0
Arizona	1,749	55.6	35.9	0.0	8.5
Arkansas	1,883	71.2	28.8	0.0	0.0
California	20,852	50.1	49.4	0.0	0.5
Colorado	3,887	92.2	7.8	0.0	0.0
Delaware	981	0.0	63.6	0.0	36.4
Florida	7,818	55.2	0.0	44.8	0.0
Georgia	1,885	78.2	20.7	0.0	1.1
Idaho	9,316	1.5	98.5	0.0	0.0
Illinois	16,088	35.5	22.1	15.0	27.4
Indiana	13,756	16.1	35.1	26.0	22.8
Iowa	5,102	92.7	5.7	0.0	1.6
Kansas	28,068	85.0	15.0	0.0	0.0
Kentucky	2,405	55.7	44.3	0.0	0.0
Louisiana	2,472	32.8	1.7	64.3	1.2
Maine	0	0.0	0.0	0.0	0.0
Maryland	218	0.0	55.5	0.0	44.5
Michigan	604	94.0	6.0	0.0	0.0
Minnesota	115,594	66.1	33.3	0.0	0.6
Mississippi	944	3.8	96.2	0.0	0.0
Missouri	52,843	76.4	16.0	7.6	0.0
Montana	34	0.0	100.0	0.0	0.0
Nebraska	11,155	56.9	26.6	0.0	16.5
Nevada	0	0.0	0.0	0.0	0.0
New Jersey	0	0.0	0.0	0.0	0.0
New Mexico	0	0.0	0.0	0.0	0.0
New York	65,060	32.0	0.0	68.0	0.0
North Carolina	7,386	90.8	9.2	0.0	0.0
North Dakota	0	0.0	0.0	0.0	0.0
Ohio	11,299	8.6	23.2	23.3	44.9
Oklahoma	33,225	68.1	31.9	0.0	0.0
Oregon	1,967	9.6	90.4	0.0	0.0
Pennsylvania	20,334	50.3	46.4	0.0	3.3
South Carolina	1,380	85.5	10.9	0.0	3.6
South Dakota	117	0.0	100.0	0.0	0.0
Tennessee	32,893	22.9	6.9	57.6	12.6
Texas	66,192	76.6	23.4	0.0	0.0
Utah	4,876	36.6	63.4	0.0	0.0
Vermont	14	92.9	7.1	0.0	0.0
Virginia	9,059	83.1	13.6	0.0	3.3
Washington	30,306	48.9	46.9	0.0	4.2
Wisconsin	96	32.3	59.4	0.0	8.3
Wyoming	158	8.5	22.2	0.0	69.6
Total receipts	589,594	56.1	25.3	14.7	3.9

Note: These data exclude the receipts at port areas (see Table 6).

The 1970 and 1977 destinations for wheat shipped by marketing firms in the eastern Corn Belt to interstate domestic destinations and to ports are shown in Table 7. In 1970, the major markets for eastern Corn Belt wheat were located in north-central and northeastern states, and these markets accounted for 56.8 percent of the total volume shipped. The balance was divided about equally between southern markets and export markets. By 1977, shipments to north central markets had declined from 36 million bushels to 12 million bushels. Shipments to northeastern states were maintained; however, movements to southern states decreased 49 percent to a total of 9.7 million bushels. Substantial declines occurred in movements to Georgia and Tennessee. The most dramatic change occurred in the volume moving to ports for export. In 1977, eastern Corn Belt states shipped 107 million bushels to ports, an increase of 424 percent since 1970.

Some fairly substantial changes also occurred in the volume and origins of wheat received in the eight southern states. The total volume of wheat received in these states from origins in other states increased from 30.7 million bushels in 1970 to 51.4 million bushels in 1977, an increase of 68 percent (Table 8). Total interstate receipts from sources of soft wheat remained fairly constant; therefore, the decline in movements from eastern Corn Belt origins was offset by an increase in interstate receipts from southern states. The gain in total receipts represented an increase in receipts from sources of hard wheat. Kansas and Minnesota were the major sources, originating 77 percent of the hard wheat shipments to the eight southern states in 1977. The wheat shipped from Minnesota was predominantly of

Table 6. Receipts of Wheat at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Great Lakes					
Duluth-Superior	152,038	69.6	30.4	0.0	0.0
Chicago	23,090	31.6	60.8	6.5	1.1
Toledo	20,522	12.0	78.0	0.0	10.0
Saginaw	2,412	0.0	100.0	0.0	0.0
Subtotal	198,062	58.3	39.7	0.8	1.2
Atlantic					
North Atlantic	13,607	100.0	0.0	0.0	0.0
South Atlantic	23,873	89.7	7.8	2.3	0.2
Subtotal	37,480	93.5	4.9	1.5	0.1
Gulf					
East Gulf	12,673	45.9	4.2	49.9	0.0
Mississippi River	174,291	9.3	0.2	90.5	0.0
North Texas Gulf	284,543	92.1	7.4	0.5	0.0
South Texas Gulf	32,389	96.9	3.1	0.0	0.0
Subtotal	503,896	62.6	0.5	32.9	0.0
Pacific					
Columbia River	267,851	34.8	10.9	54.3	0.0
Puget Sound	54,964	98.3	1.4	0.3	0.0
California	13,947	21.7	7.3	0.0	71.0
Subtotal	336,762	44.6	9.2	43.2	3.0
Total receipts	1,076,200	57.3	12.5	29.1	1.1

Table 7. Comparison of 1970 and 1977 Interstate Wheat Shipments to Various Destinations from Eastern Corn Belt Origins

Destination	Year	
	1970	1977
	thousands of bushels	
North-central states	35,820	12,010
Northeastern states	16,121	16,255
Western states	29	0
Subtotal	51,970	28,265
Southern states		
Alabama	1,338	723
Florida	2	0
Georgia	3,668	168
Kentucky	2,361	1,045
Louisiana	0	75
Mississippi	0	260
North Carolina	1,827	1,514
South Carolina	112	1,059
Tennessee	8,065	2,968
Virginia and West Virginia	1,659	1,909
Subtotal	19,032	9,721
Ports (for export)	20,518	107,425
Total volume	91,520	145,411

Sources: (*10, 14*).
Note: Origin states included are Illinois, Indiana, and Ohio.

the higher protein hard red spring class. This wheat is blended with the lower protein hard red winter wheat shipped from Kansas and other Great Plains states for use in the production of bread flours.

The data in Table 8 understate the actual receipts of hard wheat for domestic use in the eight-state region in 1977 because data collected from hard wheat mills in Louisiana were aggregated with Louisiana port elevator receipts to avoid disclosure of information about the operations of individual firms. The two Louisiana mills have a combined daily capacity of 10,000 hundredweights of flour, and that volume represents about 50 percent of the total increase in capacity in the eight-state area between 1970 and 1977.

Construction of new mills or expansion of existing mills increased daily milling capacity in Florida and Virginia by 9,700 hundredweights and 10,814 hundredweights, respectively. All of the new capacity in Florida and a large portion of the new capacity in Virginia was for the milling of hard wheat. Consequently, the southern states were a growing domestic market for hard wheats during the 1970s, a trend that is likely to continue as the population of that region continues to grow.

Developments in Recent Years

The volume of wheat processed by the flour milling industry has expanded only slightly since 1977. Consequently, the pattern of flow to domestic markets has not changed greatly from that shown in Figure 3. In contrast, exports of U.S. wheat have expanded rapidly, increasing from 1.05 billion bushels in 1977–78 to more than 1.7 billion bushels in 1981–82 (Table 9). These data exclude the exportation of

Table 8. Comparison of the Volume of Wheat Received in Eight Southern States from Out-of-State Origins in 1970 and 1977

Origin	Year	
	1970	1977
	thousands of bushels	
Soft Wheat		
Southern states[a]	2,741	12,061
Illinois	6,832	1,482
Indiana	5,897	4,194
Michigan	1,707	0
Ohio	2,815	621
Subtotal	19,992	18,359
Hard Wheat		
Iowa	0	280
Kansas	3,989	10,994
Minnesota	3,519	14,450
Missouri	3,205	3,569
Nebraska	0	1,972
Oklahoma	0	1,120
Texas	1	696
Subtotal	10,714	33,081
Total volume[b]	30,706	51,440

Sources: (*10, 14*).

Note: The states included are Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, South Carolina, and Tennessee.

[a] Includes the eight southern states listed in above note plus Florida, North Carolina, Virginia, and West Virginia.

[b] These data exclude wheat received at the ports of Mobile, Alabama; North Charleston, South Carolina; and Pascagoula, Mississippi.

wheat products, which has ranged from 70 to 87 million bushels (wheat equivalent) during these years.

The hard red winter, soft red winter, and white classes of wheat have exhibited the greatest growth in export volume in recent years. Although Gulf ports continue to dominate in exports of hard red winter wheat, the Pacific ports have handled a sizable volume of that class in recent years. These data would suggest that a sizable increase has occurred in the volume of wheat moving by rail from the Great Plains states to those port regions. The increase in exports of soft red winter and white wheats would not have the same overall impact on the demand for transportation services since these wheats must move shorter distances. The volume of soft red winter moving by barge to Louisiana ports has increased substantially (Appendix Tables 1-6).

Corn Marketing Patterns

A large volume of corn must be transported in the United States because the production of this crop is concentrated in nine midwestern states and the large export demand is channeled primarily through the Gulf Coast export region. In 1977 the Corn Belt states (Illinois, Indiana, Iowa, Missouri, and Ohio) produced 3.5 billion bushels, or 54 percent of the total for the nation. The Great Lakes states (Michigan, Minnesota, and Wisconsin) produced more than 17 percent of the total, and Nebraska produced another 10 percent. Together, these nine states produced almost 5.3 billion bushels, or 81 percent of the 6.5 billion bushels produced in the nation (Table 10).

Domestic use for feed, seed, and industrial purposes in each state was estimated using the flow data in conjunction with published data on inventories and production. These estimates are shown in Table 10. The total net use includes corn processed into products for domestic use and processed corn products for export. Iowa led all states in the quantity of corn used; in 1977 net use in that state approached 600 million bushels. Illinois ranked second, with net use exceeding 430 million bushels. Indiana, Minnesota, Nebraska, and Wisconsin ranked third through sixth, respectively, in corn utilization, each exceeding 220 million bushels. More than 2 billion bushels were used in these six states in 1977.

Shipments by State

Grain marketing firms in the United States reported shipping an estimated 5.1 billion bushels of corn in 1977 (Table 11). That total excludes the volume loaded aboard ships by export elevators; a portion of the total, however, is accounted for by the same corn being shipped in sequence by several firms. The volume of corn marketed from U.S. farms in 1976 and 1977 averaged about 4 billion bushels; therefore, about 25 percent of the total volume shipped to all destinations

Table 9. Quantity of Wheat Inspected for Export at Each Export Region by Class of Wheat, 1976-77 to 1981-82

Class of wheat and marketing year	Export region				
	Great Lakes[a]	Atlantic	Gulf[b]	Pacific	Total
	millions of bushels				
Hard Red Spring					
1976-77	31.4	0.0	36.8	49.0	117.2
1977-78	54.6	0.6	40.7	62.2	148.1
1978-79	107.7	0.0	42.6	73.8	224.1
1979-80	74.1	0.0	47.5	84.0	205.6
1980-81	64.1	0.0	41.9	70.8	176.8
1981-82	58.4	0.0	54.9	84.3	197.6
Hard Red Winter					
1976-77	0.1	0.0	293.8	87.6	381.5
1977-78	0.2	0.0	413.6	77.8	491.6
1978-79	0.1	0.0	452.4	112.9	565.4
1979-80	0.0	0.0	526.2	142.1	668.3
1980-81	0.0	0.0	475.4	165.5	640.9
1981-82	0.0	0.0	580.9	135.5	716.4
Soft Red Winter					
1976-77	6.2	50.4	115.1	0.0	171.7
1977-78	22.6	51.2	110.0	0.0	183.8
1978-79	24.3	15.5	49.6	0.0	89.4
1979-80	7.2	32.3	98.8	0.0	138.3
1980-81	13.2	75.8	198.8	0.0	287.8
1981-82	9.1	119.4	323.9	0.0	452.4
White					
1976-77	1.3	3.4	0.0	172.7	177.4
1977-78	2.1	5.1	0.0	158.3	165.6
1978-79	2.5	0.0	0.0	172.4	174.9
1979-80	5.2	5.0	0.0	177.5	187.7
1980-81	2.2	0.5	0.0	252.2	254.9
1981-82	8.6	5.0	0.3	245.5	259.4
Durum					
1976-77	15.6	0.0	10.1	13.9	39.6
1977-78	48.7	0.3	4.4	5.0	58.4
1978-79	52.8	0.0	2.8	10.3	65.9
1979-80	55.6	0.0	16.3	7.4	79.3
1980-81	29.1	0.0	9.1	13.6	51.8
1981-82	37.8	0.0	13.3	20.1	71.2
Mixed					
1976-77	0.0	0.0	0.3	0.0	0.3
1977-78	0.0	0.0	4.8	1.5	6.3
1978-79	1.1	0.0	3.3	0.0	4.4
1979-80	0.0	0.0	10.9	0.0	10.9
1980-81	0.0	0.0	10.4	0.0	10.4
1981-82	0.0	0.0	7.1	0.0	7.1
All Classes					
1976-77	54.7	53.9	456.0	323.2	887.8
1977-78	118.3	57.1	573.5	304.8	1,053.7
1978-79	188.4	15.5	550.8	369.4	1,124.1
1979-80	142.1	37.4	699.7	411.0	1,290.2
1980-81	108.6	76.4	735.6	502.1	1,422.7
1981-82	113.9	124.4	980.4	485.4	1,704.1

Source: (*18*)

[a] Includes exports of U.S. wheat from Canadian ports.

[b] Includes rail shipments to Mexico inspected at interior points.

was shipped more than once. For example, over 17 million bushels of the corn shipped to the Chicago port area were reshipped to other domestic port regions. These reshipments frequently involve river elevators. In Illinois, for example, over two-thirds of the corn handled by river elevators in 1977 was shipped to those firms by country elevators. (The balance was shipped directly from nearby farms.) The same general pattern existed in other states that shipped large volumes of corn by barge or through inland terminal or subterminal elevators.

Shipments to domestic destinations within the originating state accounted for 2.37 billion bushels, or 46.5 percent of the total. Illinois and Iowa together accounted for 47 percent of the intrastate shipments. Minnesota and Nebraska each had intrastate movements in excess of 200 million bushels. About one-half of these intrastate flows are shipments from country elevators to river and terminal elevators, from which the corn is reshipped to destinations in other states or to ports. Eighty-eight percent of the intrastate shipments were carried by trucks (75 percent by commercial truckers and 13 percent by farm trucks). Only 11 percent of the intrastate shipments went by rail.

The demand for transportation equipment to move corn is reflected in the volume shipped across state boundaries to domestic destinations and export regions. A majority of these shipments move long distances by either rail or barge. Marketing firms shipped more than 1 billion bushels in 1977 to domestic markets in other states (Table 11). An additional 1.7 billion bushels were shipped to various export regions, and about 93 percent of that total moved in interstate commerce. Interstate shipments in 1977 totaled 2.6 billion bushels, 49 percent of which was transported by rail.

Barges hauled 905 million bushels, or about 35 percent of the total transported across state lines. Truck shipments accounted for only 16 percent of the interstate total. Domestic corn flows are illustrated in Figure 5.

Almost all states shipped some corn to domestic markets in other states; in terms of volume, however, the origins of these shipments are highly concentrated. Four states (Illinois, Indiana, Iowa, and Nebraska) accounted for 710 million bushels, or 70 percent of the total

Table 10. Supply and Utilization of Corn by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama	24.1	10.9	93.1	128.1	1.3	19.5	10.3	97.0
Arizona	1.9	5.0	3.8	10.7	0.0	0.0	4.3	6.4
Arkansas	1.7	2.3	81.9	85.9	0.3	0.0	2.0	83.6
California	16.8	28.7	95.9	141.4	0.0	13.9	16.7	110.8
Colorado	43.5	80.6	48.8	172.9	9.3	0.0	55.0	108.6
Connecticut	0.0	0.0	9.4	9.4	0.0	0.0	0.0	9.4
Delaware	11.6	9.7	10.1	31.4	7.6	0.0	8.5	15.3
Florida	5.5	10.5	18.4	34.4	1.2	0.0	3.8	29.4
Georgia	72.5	24.0	75.9	172.4	9.5	0.0	24.7	138.2
Idaho	2.0	3.4	0.0	5.4	0.0	0.0	1.4	4.0
Illinois	1,012.3	1,184.4	148.3	2,345.0	839.7	32.4	1,041.2	431.7
Indiana	478.4	633.4	40.9	1,152.7	419.3	0.0	459.3	274.1
Iowa	1,050.1	1,092.2	17.7	2,160.0	432.8	0.0	1,128.4	598.8
Kansas	121.9	161.3	49.4	332.6	35.2	0.0	125.7	171.7
Kentucky	107.6	132.3	23.4	263.3	83.0	0.0	96.5	83.8
Louisiana	14.8	3.4	1,033.6	1,051.8	0.8	954.0	15.6	81.4
Maine	0.0	0.0	13.4	13.4	0.0	0.0	0.0	13.4
Maryland	44.9	43.2	143.2	231.3	10.0	131.9	31.3	58.1
Massachusetts	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.4
Michigan	99.7	211.6	0.2	311.5	74.7	3.6	144.1	89.1
Minnesota	304.0	600.0	33.0	937.0	126.6	5.6	556.8	248.0
Mississippi	5.1	5.8	55.2	66.1	1.9	2.8	3.9	57.5
Missouri	129.7	201.4	45.0	376.1	66.9	0.0	151.2	158.0
Montana	0.6	0.7	0.0	1.3	0.0	0.0	0.8	0.5
Nebraska	433.0	648.4	11.6	1,093.0	260.9	0.0	593.9	238.2
Nevada	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
New Hampshire	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
New Jersey	5.0	6.9	0.7	12.6	3.2	0.0	5.1	4.3
New Mexico	6.2	10.3	0.6	17.1	0.3	0.0	6.1	10.7
New York	41.1	55.7	27.0	123.8	5.8	12.5	37.6	67.9
North Carolina	77.0	88.7	30.1	195.8	26.2	0.0	51.4	118.2
North Dakota	5.5	19.0	2.6	27.1	6.9	0.0	15.2	5.0
Ohio	287.2	380.1	69.5	736.8	206.3	84.9	293.1	152.5
Oklahoma	4.3	7.8	7.1	19.2	0.9	0.0	4.9	13.4
Oregon	0.7	1.1	7.2	9.0	0.0	0.1	0.9	8.0
Pennsylvania	76.8	111.3	59.6	247.7	4.3	44.4	74.4	124.6
South Carolina	24.6	26.9	17.5	69.0	3.3	4.3	19.4	42.0
South Dakota	38.6	126.8	5.1	170.5	7.1	0.0	92.9	70.5
Tennessee	33.0	49.6	43.3	125.9	7.2	0.0	32.5	86.2
Texas	126.9	161.7	116.3	404.9	11.6	91.9	126.7	174.7
Utah	1.1	1.2	4.2	6.5	0.0	0.0	0.7	5.8
Vermont	0.0	0.0	4.6	4.6	0.0	0.0	0.0	4.6
Virginia	37.2	33.3	182.0	252.5	3.7	137.6	23.5	87.7
Washington	2.8	7.6	13.8	24.2	0.0	0.0	6.7	17.5
West Virginia	4.5	4.0	2.3	10.8	0.2	0.0	5.5	5.1
Wisconsin	133.8	317.2	52.7	503.7	32.7	19.7	229.3	222.0
Wyoming	1.5	2.6	1.5	5.6	0.0	0.0	1.7	3.9
Total volume	4,889.5	6,505.0	2,700.7	14,095.2	2,700.7	1,559.1	5,503.0	4,332.4

Sources: (*5, 16, 17*).

(Table 11). Ohio was a distant fifth with 62 million bushels.

Nebraska led all other states in shipments to out-of-state domestic markets; the total volume in 1977 was almost 221 million bushels. California was the leading destination for Nebraska corn. Shipments to that state totaled 65 million bushels. Arkansas, Colorado, and Kansas each received 30 million bushels or more of Nebraska corn.

Firms in Illinois shipped 180 million bushels to domestic markets, and three-fourths of that total went to five destination states (Alabama, Georgia, Louisiana, Mississippi, and Tennessee). The primary out-of-state domestic markets for Indiana corn were Illinois, Georgia, and Alabama, which together received 62 percent of the Indiana shipments. The primary domestic markets for Iowa corn were located in Arkansas, Illinois, Missouri, and Wisconsin; shipments to each of these destinations totaled over 20 million bushels. The primary domestic markets for Ohio corn were the Carolinas and the Northeast.

The geographic area from which corn moved to export regions was even more restricted than that for domestic movements. Five states (Illinois, Indiana, Iowa, Minnesota, and Ohio) originated 1.45 billion bushels, or 85 percent of the total. Illinois firms shipped 653 million bushels, or 38 percent of the total, and 77 percent of shipments from Illinois moved by barge. Iowa and Minnesota were the other major origins of barge movements to ports. Shipments from Indiana and Ohio to export regions moved predominantly in trainload units. The pattern of corn flows to port destinations is illustrated in Figure 6.

The destinations for shipments to export regions from each originating state are shown in Table 12. Shipments to all export regions totaled 1.74 billion bushels in 1977. That amount includes 29 million bushels that moved directly from farms to port elevators. Ports located in the Gulf region were the destination for 1.1 billion bushels, or 64 percent of the total. Illinois,

Table 11. 1977 Shipments of Corn to Domestic Destinations and Export Regions by Marketing Firms in Each Originating State or Port Area

Originating state or port area	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the state	In other states		
	thousands of bushels			
States				
Alabama	17,425	1,281	3,442	22,148
Arizona	2,656	0	0	2,656
Arkansas	21,209	60	0	21,269
California	20,861	0	429	21,290
Colorado	7,621	9,322	0	16,943
Delaware	7,448	4,795	1,397	13,640
Florida	6,300	0	1,189	7,489
Georgia	37,354	9,210	215	46,779
Illinois	611,003	179,871	653,303	1,444,177
Indiana	178,768	175,756	212,147	566,671
Iowa	499,632	133,508	291,139	924,279
Kansas	51,467	29,465	6,015	86,947
Kentucky	11,813	34,789	46,769	93,371
Louisiana	2,846	6	180	3,032
Maryland	7,963	7,334	6,676	21,973
Michigan	13,869	21,246	49,078	84,193
Minnesota	252,839	25,185	108,895	386,919
Mississippi	4,275	1,572	216	6,063
Missouri	49,198	31,785	30,549	111,532
Nebraska	238,297	220,923	36,508	495,728
New Jersey	0	731	2,159	2,890
New Mexico	0	312	0	312
New York	1,155	2,642	1,092	4,889
North Carolina	52,908	2,434	20,286	75,628
North Dakota	0	6,653	248	6,901
Ohio	77,719	62,235	188,959	328,913
Oklahoma	0	780	97	877
Pennsylvania	34,598	2,904	2,367	39,869
South Carolina	5,960	2,627	4,354	12,941
South Dakota	0	4,833	1,789	6,622
Tennessee	13,144	4,887	2,231	20,262
Texas	129,682	11,601	3,791	145,074
Vermont	4	0	0	4
Virginia	2,425	0	1,611	4,036
Wisconsin	8,391	19,742	22,571	50,704
Wyoming	45	0	0	45
Port Areas				
Chicago-Milwaukee	540	1,708	14,904	17,152
South Atlantic	779	2,789	95	3,663
Louisiana Gulf	1,764	786	0	2,550
Total volume	2,371,958	1,013,772	1,714,701	5,100,431
Percentage of total volume	46.5	19.9	33.6	100.0

Note: The data in this table exclude export elevator shipments to foreign destinations by water.

Iowa, and Minnesota originated 84 percent of the total volume shipped to Gulf ports. Atlantic ports received 22 percent of the total, primarily from Indiana and Ohio. Great Lake ports received corn from several states in the Corn Belt and Great Lakes regions. Only 27 million bushels moved to Pacific ports in 1977, most of that amount originating in Nebraska.

Receipts at Domestic Destinations and Port Areas

In contrast to the highly concentrated origins of interstate domestic corn movements, the destinations of domestic shipments were widely dispersed. Almost 1.1 billion bushels were received from sources in other states by marketing firms in 45 states (Table 13). Interstate shipments were made to all states except Montana, Nevada, and Rhode Island. It is interesting that Illinois, a major corn producer, received almost 93 million bushels, thus leading all states in receipts from other states. The major broiler-producing states, Arkansas, Alabama, Georgia, and Mississippi, were important domestic markets in the South. Those states received 287 million

Figure 5. Pattern of corn flows to domestic destinations in 1977.

Figure 6. Pattern of corn flows to port areas in 1977.

bushels of corn from other states, mostly from the Corn Belt region. California and Colorado were major markets in the West, receiving 85.5 million bushels and 38.7 million bushels, respectively. Shipments to these states moved primarily by rail; Nebraska was the principal origin.

Sixty percent of the total volume moving across state lines to domestic destinations was shipped by rail, which was the predominant mode of transportation for shipments received in 31 states. Only 3.5 percent of the corn that moved to domestic destinations was shipped by barge. Alabama was the principal destination. Firms in that state received more than 28 million bushels by barge. Trucks carried 28.5 percent of the total interstate volume. Truck shipments usually moved between adjoining states.

In contrast to flows to domestic destinations, 50 percent of the 1.7 billion bushels received at port areas were transported by barge (Table 14). Port elevators along the Mississippi River in Louisiana received 1 billion bushels, 85 percent of which were carried by barges. At Atlantic ports, on the other hand, 88 percent of the total received was transported by rail. A sizable portion of the corn received was shipped from eastern Corn Belt states in trainload units.

Ports along the Great Lakes are supplied primarily by truck shipments originating in adjacent states. In the Duluth-Superior port area, rail shipments predominated, but the volume was relatively small. About 25 percent of receipts in the Chicago area moved there by rail. Iowa was the principal origin. Movements directly from farms to port elevators were quite common in California, accounting for one-third of all receipts. About 9 million bushels of corn were received directly from farms in the Chicago and Toledo port areas.

Table 12. 1977 Movements of Corn to Export Regions from Individual States and Port Areas

Originating state or port area	Export region				Total
	Great Lakes[a]	Atlantic Coast	Gulf Coast[b]	Pacific Coast	
	thousands of bushels				
States					
Alabama	0	0	3,542	0	3,542
California	0	0	0	5,704	5,704
Delaware	0	1,397	0	0	1,397
Florida	0	0	1,189	0	1,189
Georgia	0	215	0	0	215
Illinois	31,351	35,820	586,227	0	653,398
Indiana	28,963	163,364	20,448	0	212,775
Iowa	32,828	0	253,923	4,388	291,139
Kansas	0	0	5,923	92	6,015
Kentucky	0	0	46,769	0	46,769
Louisiana	0	0	180	0	180
Maryland	0	8,625	0	0	8,625
Michigan	34,258	19,835	0	0	54,093
Minnesota	7,793	0	101,102	0	108,895
Mississippi	0	0	216	0	216
Missouri	0	0	30,549	0	30,549
Nebraska	0	0	19,735	16,773	36,508
New Jersey	0	2,159	0	0	2,159
New York	0	1,092	0	0	1,092
North Carolina	0	20,286	0	0	20,286
North Dakota	248	0	0	0	248
Ohio	48,129	115,110	28,230	0	192,469
Oklahoma	0	0	97	0	97
Pennsylvania	0	2,367	0	0	2,367
South Carolina	0	4,999	0	0	4,999
South Dakota	727	0	604	458	1,789
Tennessee	0	0	2,231	0	2,231
Texas	0	0	3,791	0	3,791
Virginia	0	5,234	0	0	5,234
Wisconsin	27,682	0	3,350	0	31,032
Port Areas					
Chicago-Milwaukee	4,392	2,202	8,310	0	14,904
South Atlantic	0	95	0	0	95
Total volume	217,371	382,800	1,116,416	27,415	1,744,002
Percentage of total volume	12.5	21.9	64.0	1.6	100.0

Note: The data in this table include shipments that moved directly to port elevators from farms. Those shipments are excluded from Table 11.

[a] Includes shipments to Canada of 1,278,000 bushels from Illinois and 2,668,000 bushels from Minnesota.

[b] Includes shipments to Mexico of 260,000 bushels from Kansas and 360,000 bushels from Texas.

Changes in the Pattern of Domestic Flows

Previous surveys have been incomplete in their geographical coverage. It is therefore not possible to fully evaluate changes in corn flow patterns over time. Market flow patterns constantly change as sellers attempt to take advantage of profitable marketing opportunities. Likewise, buyers continuously seek the most economical source of supply. The local supply and demand situation varies throughout the marketing year. Consequently, changes in the supply, the demand, and the cost and availability of transportation services result in frequent changes in the most profitable shipping patterns.

Comparing movements at differ-

ent times can reveal trends in corn flow patterns. A survey of 1970 grain movements between the Corn Belt and the South was conducted by the SM-42 Regional Research Committee. Representatives from eight southern states and three Corn Belt states participated in that survey, and the results emphasized the very special and important relationships among the areas studied. The South, with its large grain-consuming animal industry (comprising mainly the production of various classes of poultry), uses more feed grain than it produces. Although certain areas of the South may have surpluses of feed grains at harvesttime, the southern states are net importers during most of the year.

Table 13. Volume of Corn Received in Various States from Origins Outside the State and Percentage Carried by Each Mode of Transportation in 1977

Destination state	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Alabama	76,799	53.8	9.3	36.9	0.0
Arizona	3,828	80.4	19.6	0.0	0.0
Arkansas	80,372	91.2	8.8	0.0	0.0
California	85,539	99.4	0.6	0.0	0.0
Colorado	38,704	92.6	7.4	0.0	0.0
Connecticut	9,395	100.0	0.0	0.0	0.0
Delaware	10,054	0.0	71.4	28.6	0.0
Florida	18,389	78.3	12.2	9.5	0.0
Georgia	75,893	96.2	2.7	0.0	1.1
Illinois	92,944	33.5	56.3	0.0	10.2
Indiana	40,856	9.9	35.8	0.0	54.3
Iowa	17,600	19.5	80.1	0.0	0.4
Kansas	44,766	51.5	40.9	0.0	7.6
Kentucky	23,360	15.8	24.3	0.0	59.9
Louisiana	31,008	80.6	15.0	4.4	0.0
Maine	13,354	100.0	0.0	0.0	0.0
Maryland	9,832	6.1	69.2	1.2	23.5
Massachusetts	440	100.0	0.0	0.0	0.0
Michigan	156	0.0	100.0	0.0	0.0
Minnesota	25,984	4.3	72.3	0.0	23.4
Mississippi	53,989	69.4	21.9	8.7	0.0
Missouri	44,990	58.1	41.9	0.0	0.0
Nebraska	11,645	8.3	65.3	0.0	26.4
Nevada	162	100.0	0.0	0.0	0.0
New Hampshire	194	84.5	15.5	0.0	0.0
New Jersey	744	50.7	49.3	0.0	0.0
New Mexico	636	100.0	0.0	0.0	0.0
New York	17,981	97.9	2.1	0.0	0.0
North Carolina	30,063	92.7	7.3	0.0	0.0
North Dakota	2,596	57.6	42.4	0.0	0.0
Ohio	33,728	0.0	51.2	0.0	48.8
Oklahoma	7,074	48.7	51.3	0.0	0.0
Oregon	5,674	98.6	1.4	0.0	0.0
Pennsylvania	16,328	43.8	38.7	0.0	17.5
South Carolina	17,101	92.6	6.9	0.0	0.5
South Dakota	4,910	4.2	95.8	0.0	0.0
Tennessee	43,319	65.0	31.6	1.9	1.5
Texas	28,424	55.7	44.3	0.0	0.0
Utah	4,222	90.5	9.5	0.0	0.0
Vermont	4,578	91.2	5.2	0.0	3.6
Virginia	5,946	29.7	5.8	6.0	58.5
Washington	3,993	100.0	0.0	0.0	0.0
West Virginia	2,301	99.1	0.9	0.0	0.0
Wisconsin	40,945	12.3	84.4	0.0	3.3
Wyoming	628	79.6	20.4	0.0	0.0
Total receipts	1,077,707	60.1	28.5	3.5	7.9

Note: These data exclude the receipts at port areas (see Table 14).

The Corn Belt, on the other hand, produces a surplus of corn and depends upon markets outside the local area. Corn Belt states have been moving an ever-increasing share of their supplies to points of export in recent years. However, because of their proximity and the availability of existing transportation networks, the Corn Belt and the South continue to be business partners in the feed-grain and livestock economy. This special relationship makes it desirable to compare selected information from the 1970 survey with selected results from the 1977 survey to study changes in trade patterns (Table 15).

Several factors have resulted in changes in corn trading between these two regions. First, corn production doubled in the 12 southern states between 1969 and 1976, from 340 million bushels to 681 million bushels. This expansion exceeded the growth in corn feeding, and as a result feed grain shipments from eastern Corn Belt origins to the South declined by 25 percent. Second, corn production in the eastern Corn Belt increased 42 percent during these years, and marketing firms were forced to seek other markets, mainly through exportation. In 1970, 44 percent of interstate shipments moved to the South, 38 percent to export points, and 18 percent to other domestic destinations. In contrast, only 19 percent of interstate movements in 1977 were

directed to southern markets; 72 percent went to ports, and only 9 percent moved to other domestic points. This trend was most evident in Ohio, where the proportion of interstate shipments to port locations increased from 23 percent in 1970 to 75 percent in 1977. Export destinations received 40 percent of Illinois's interstate shipments in 1970 but 78 percent in 1977.

A comparison of 1970 and 1977 interstate corn receipts in eight southern states is presented in Table 16. Total receipts declined by 56 million bushels. Movements among the southern states increased substantially and represented 11 percent of the total in 1977. The only major sources that shipped increased amounts to the eight southern states were Iowa and Nebraska. Movements from the other major origins decreased. Illinois continued to be the most important source of corn imported into those states, but the volume received from Illinois declined 65 million bushels between 1970 and 1977, a decrease of 31 percent.

Developments in Recent Years

Substantial changes have occurred in corn marketing patterns since 1977. Between 1976 and 1981, the production of corn increased from 6.3 billion bushels to 8.2 billion bushels (Table 17). The drouth-reduced crop of 1980 totaled only 6.6 billion bushels, but corn output in 1981 reached record levels. The Corn Belt has continued to be the dominant region in corn production, accounting for 55 percent of the U.S. total during the past six years. The Great Lakes states produced 15 percent of the output during the same period. Production in the latter region jumped substantially in 1977, and the higher level of output was maintained in later years. Before the 1980 drouth, production in the northern plains had increased rapidly, and by 1979 that

Table 14. Receipts of Corn at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Great Lakes					
Duluth-Superior	6,186	87.7	12.3	0.0	0.0
Chicago	118,851	24.8	64.5	3.5	7.2
Toledo	84,793	0.2	89.0	0.0	10.8
Saginaw	3,595	0.5	99.5	0.0	0.0
Subtotal	213,425	16.4	73.3	2.0	8.3
Atlantic					
North Atlantic	53,450	89.8	10.2	0.0	0.0
South Atlantic	329,350	87.9	8.6	1.6	1.9
Subtotal	382,800	88.1	8.9	1.4	1.6
Gulf					
East Gulf	20,984	55.8	10.0	33.7	0.5
Mississippi River	1,004,562	14.5	0.0[a]	85.5	0.0
North Texas Gulf	89,595	97.8	2.2	0.0	0.0
South Texas Gulf	655	80.9	19.1	0.0	0.0[a]
Subtotal	1,115,796	22.0	0.4	77.6	0.0
Pacific					
Columbia River	2,883	100.0	0.0	0.0	0.0
Puget Sound	8,477	100.0	0.0	0.0	0.0
California	16,055	64.5	2.7	0.0	32.8
Subtotal	27,415	79.2	1.6	0.0	19.2
Total receipts	1,739,436	36.8	11.2	50.3	1.7

[a] Less than 0.05 percent.

Table 15. Comparison of 1970 and 1977 Interstate Corn Shipments to Various Destinations from Eastern Corn Belt Origins

Destination	Year	
	1970	1977
	thousands of bushels	
North-central states	97,611	96,741
Northeastern states	50,202	38,575
Western states	3,880	1,778
Subtotal	151,693	137,094
Southern states		
Alabama	76,260	66,088
Arkansas	0	7,258
Florida	11,452	9,360
Georgia	68,474	63,438
Kentucky	42,239	8,137
Louisiana	13,054	22,590
Mississippi	52,098	35,533
North Carolina	19,791	22,939
South Carolina	5,816	14,716
Tennessee	56,457	27,375
Virginia and West Virginia	27,059	2,817
Subtotal	372,700	280,768
Ports (for export)	319,730	1,059,409
Total volume	844,123	1,477,271

Sources: (*5,14*).
Note: Originating states included are Illinois, Indiana, and Ohio.

region ranked second in terms of production.

Recent production in the Delta states and the Southeast is substantially below 1976 levels, whereas broiler production is about 30 percent higher than in 1976–77. As a result, corn movements from the Corn Belt to these regions have probably increased significantly since the 1977 survey. The quantity of corn fed by the dairy and swine industries has increased by 14 percent and 18 percent, respectively, since 1976–77 (*11*). Thus, corn consumption has increased in the regions where these industries are located. Overall, domestic use has increased almost 20 percent since 1977. Thus, corn movements to domestic destinations have increased substantially since the 1977 survey.

Changes in the volume exported and the share handled by the various ports have had the greatest impact on flow patterns since 1977. The most notable change is the volume exported from Pacific Coast ports (Table 18). The volume inspected for export at those ports increased from 15 million bushels in 1977 to 366 million bushels in 1980. The volume handled by those ports has declined in more recent years, however. Although California ports draw some corn from nearby origins, most of this grain is shipped from distant origins by rail. The introduction of unit train service to Pacific Coast ports is the most important reason for growth of exports from that region. Consequently, a substantial increase in flows from Nebraska, Iowa, and South Dakota occurred after 1977. The volume exported from Pacific ports is sensitive to changes in the relative cost of transporting corn from production points to foreign destinations through alternative port locations. The foreign destinations being served by Pacific Coast ports are in Southeast Asia, a rapidly growing market that was previously supplied with shipments from Gulf ports.

Table 16. Comparison of the Volume of Corn Received in Eight Southern States from Out-of-State Origins in 1970 and 1977

Origin	Year	
	1970	1977
	thousands of bushels	
Southern states	24,891	45,285
Illinois	209,476	143,989
Indiana	89,292	89,270
Iowa	28,991	47,725
Kansas	24,340	13,370
Michigan	146	223
Minnesota	10,825	1,004
Missouri	29,075	17,677
Nebraska	22,840	31,795
Ohio	15,630	11,435
Texas	0	68
Wisconsin	2,094	0
Total volume	457,600	401,841

Sources: (*5, 14*).

Note: The states included are Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, South Carolina, and Tennessee.

Table 17. Regional Shifts in Corn Production Between 1976 and 1981

Region[a]	Crop year					
	1976	1977	1978	1979	1980	1981
	millions of bushels					
Northeast	238	227	249	265	230	309
Lake states	643	1,129	1,132	1,161	1,206	1,396
Corn Belt	3,674	3,492	3,966	4,411	3,682	4,441
Northern plains	736	956	1,117	1,229	859	1,162
Appalachian	403	308	344	370	274	407
Southeast	263	72	151	190	109	154
Delta states	15	11	12	10	5	12
Southern plains	196	169	148	141	122	131
Mountain	83	104	105	118	112	137
Pacific	38	37	44	44	49	53
Total production	6,289	6,505	7,268	7,939	6,648	8,202

Sources: (*15,16*).

[a] The states included in each region are as follows: Northeast — Delaware, Maryland, New Jersey, New York, and Pennsylvania; Lake states — Michigan, Minnesota, and Wisconsin; Corn Belt — Illinois, Indiana, Iowa, Missouri, and Ohio; Northern plains — Kansas, Nebraska, North Dakota and South Dakota; Appalachian — Kentucky, North Carolina, Tennessee, and Virginia; Southeast — Alabama, Florida, Georgia, and South Carolina; Delta states — Arkansas, Louisiana, and Mississippi; Southern plains — Oklahoma and Texas; Mountain — Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, and Wyoming; and Pacific — California, Oregon, and Washington.

Ports on the Great Lakes are highly dependent upon corn that is trucked from adjacent states. The volume shipped from the Chicago-Milwaukee port area expanded rapidly between 1977 and 1979. In 1980 the volume handled at Toledo continued to increase, whereas the Chicago-Milwaukee total decreased. These changes reflect the impact of the 1980 drouth in Illinois and Indiana and large crops in Michigan and Ohio that year. The Atlantic Coast ports compete with

Table 18. Quantity of Corn Inspected for Export at Each Export Region, 1977 to 1982

Export region and port area[a]	Calendar year					
	1977	1978	1979	1980	1981	1982
	millions of bushels					
Great Lakes[b]						
Duluth-Superior	5.5	56.6	51.2	41.9	60.2	31.6
Chicago-Milwaukee	48.4	74.9	118.6	72.2	8.5	2.9
Toledo	84.9	98.0	103.8	116.0	85.7	84.5
Saginaw	3.6	5.9	6.0	4.7	1.1	2.1
Subtotal	142.4	235.4	279.6	234.8	155.5	121.1
Atlantic						
North Atlantic	58.8	82.9	111.2	101.0	54.2	85.8
South Atlantic	299.1	290.8	342.2	268.6	274.5	323.9
Subtotal	357.9	373.7	453.4	369.6	328.7	409.7
Gulf						
East Gulf	19.0	111.2	91.9	123.9	1,219.5	1,245.0
Mississippi River	950.5	1,008.7	1,130.3	1,174.3	40.6	18.4
North Texas Gulf	91.8	108.8	127.2	153.7	105.9	50.9
South Texas Gulf	0.4	0.2	5.4	0.9	0.5	0.0
Subtotal	1,076.7	1,228.9	1,354.8	1,452.8	1,366.5	1,314.3
Pacific						
Columbia River	0.0	0.1	0.0	0.0	0.3	5.4
Puget Sound	0.0	67.9	170.6	269.5	202.6	51.4
California	14.8	49.9	78.5	96.8	68.5	24.5
Subtotal	14.8	117.9	249.1	366.3	271.4	81.3
Interior points[c]	NA	NA	NA	47.5	38.4	0.2
Total inspected	1,567.8	1,955.9	2,336.9	2,471.0	2,160.5	1,926.6

Source: (*18*).
NA = not available.
[a] See Table 1 for a list of ports included in each area.
[b] Includes waterway shipments to Canada.
[c] Rail and truck movements to Canada and Mexico.

Toledo for shipments originating in Indiana, Michigan, and Ohio. Again, the relative total costs of transportation from origin to foreign destination is an important factor in determining the comparative advantage of each port.

The Gulf region continues to dominate in corn exports, with inspections averaging about 1.3 billion bushels in the last five years, up from 1.1 billion bushels in 1977 (Table 18). Although that increase was the largest of any region, the Gulf ports' share of total exports decreased from 67 percent in 1977 to 59 percent in 1980. In 1982, 68 percent of all exports were handled by Gulf ports. This changing market share reflects the capacity limitations at Gulf ports and the more favorable ocean freight rates from Pacific ports to Southeast Asia during some years. The Gulf ports, however, continue to enjoy the advantage of barge transportation from major corn-producing states. Barge shipments of corn have increased substantially since 1977 (see Appendix Tables 1 through 6), and much of that volume is destined for Gulf ports.

Soybean Marketing Patterns

The volume of soybeans that must be transported is large because production of the crop is concentrated in several geographic areas and because the very large export volume is channeled primarily through ports on the Gulf of Mexico. Soybean production is confined almost entirely to the eastern half of the country, where summer rainfall is adequate. Production is concentrated in the Corn Belt region (Illinois, Indiana, Iowa, Missouri, and Ohio) and the south-central region (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee). The Corn Belt region produced almost two-thirds of the total U.S. soybean crop in 1977, and the south-central region produced about one-fifth (Table 19).

Estimates of utilization in various states or regions were developed using the interstate movement data in Table 19. The major domestic use of soybeans is for processing. During 1977, soybean processors used about 93 percent of the total amount consumed domestically. The amount used for seed accounted for the balance. Illinois and Iowa led all states in net use, and these states together consumed about 35 percent of the total in 1977. Interstate shipments appear to be slightly overestimated for a few of the low-use states because the estimated net use for those states is negative. Stock estimates are also subject to greater estimation error in those states where inventories are relatively small.

Although soybeans are exported from all U.S. export regions, Gulf ports handled almost four-fifths of the total volume inspected for export in 1977. The Great Lakes and Atlantic regions each handled about one-tenth of the total volume shipped to destinations outside the United States. Consequently, a large volume of soybeans must be trans-

ported from the major producing states to the port areas. The inland waterway system is the vital link in moving soybeans from the production areas to the Gulf ports.

The soybean processing industry, the major domestic outlet for soybeans, has accounted for an average of 56 percent of the total soybean disappearance in the last five years. The industry is composed of 83 plants in 21 states (*13*). Seven states have only one or two plants; in those cases, the publication of flow data for individual states would reveal information about the activities of individual firms. To preserve the confidentiality of survey responses, flow data were aggregated across state lines in many instances. The following combinations of states are treated as regions in the soybean data:

- New York, New Jersey, and Pennsylvania
- Delaware, Maryland, North Carolina, and Virginia
- Florida, Georgia, and South Carolina
- Alabama and Tennessee
- Kansas and Nebraska

Shipments by Region

Grain marketing firms in the United States reported shipping an estimated 1.69 billion bushels of soybeans in 1977 (Table 20). A portion of that total is accounted for by the same soybeans being shipped in sequence by several firms. In Illinois, for example, about two-thirds of the soybeans handled by river elevators were received from country elevators. The other third moved directly from farms.

About 49 percent of the total volume transported was sent to domestic destinations within the state or region in which the shipments originated. These movements consisted predominantly of shipments from country elevators to river elevators, terminal elevators, and processors located in the same state or region.

Table 19. Supply and Utilization of Soybeans by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama and Tennessee	45.4	83.7	67.4	196.5	41.3	21.5	48.3	85.4
Arkansas	52.5	105.8	18.5	176.8	61.1	0.0	86.9	28.8
California	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.0
Delaware, Maryland, N. Carolina, and Virginia[a]	35.2	51.8	89.9	176.9	26.2	48.8	40.7	61.2
Florida, Georgia, and S. Carolina[a]	39.7	56.6	27.1	123.4	20.1	5.2	39.3	58.8
Illinois	219.6	336.3	68.1	624.0	162.5	15.0	283.7	162.8
Indiana	66.3	144.3	13.6	224.2	79.7	0.0	84.4	60.1
Iowa	218.3	251.4	19.7	489.4	101.6	0.0	242.3	145.5
Kansas and Nebraska	39.3	68.9	24.5	132.7	18.8	0.0	60.0	53.9
Kentucky	19.9	40.9	10.4	71.2	21.7	0.0	30.0	19.5
Louisiana	30.2	65.3	334.5	430.0	13.7	368.2	37.2	10.9
Michigan	5.1	23.9	0.0	29.0	19.2	1.1	11.6	−2.9
Minnesota	74.0	133.8	19.6	227.4	35.7	0.0	107.4	84.3
Mississippi	45.9	78.5	55.6	180.0	37.9	46.8	49.3	46.0
Missouri	56.3	148.8	13.3	218.4	94.7	0.0	86.0	37.7
New Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Jersey, New York, and Pennsylvania[a]	5.1	7.5	13.7	26.3	5.4	13.8	7.2	−0.1
North Dakota	1.6	3.5	0.0	5.1	3.9	0.0	3.0	−1.8
Ohio	61.4	121.8	24.1	207.3	58.2	47.1	78.5	23.5
Oklahoma	2.6	8.1	0.1	10.8	6.7	0.0	5.1	−1.0
Oregon	0.0	0.0	0.6	0.6	0.0	0.6	0.0	0.0
South Dakota	4.0	9.6	0.0	13.6	8.0	0.0	6.8	−1.2
Texas	7.0	20.1	21.1	48.2	0.5	27.4	12.8	7.5
Washington	0.0	0.0	0.4	0.4	0.0	0.4	0.0	0.0
Wisconsin	2.8	6.7	1.7	11.2	7.3	0.9	4.8	−1.8
Total volume	1,032.2	1,767.3	824.2	3,623.7	824.2	597.1	1,325.3	877.1

Sources: (*9, 16, 17*).

[a] States were combined to avoid disclosing operations of individual firms.

Soybean processing plants have traditionally been located in production areas, and a large proportion of the soybeans purchased for crushing are procured from nearby sources. Thus the predominant destination for intrastate and intraregional shipments was local processors.

In contrast, several large processing plants located in southeastern states use volumes in excess of the amount produced locally. Also, local export firms compete with processors for the soybeans produced in many of these states. Thus it is often more profitable for southeastern processors to purchase soybeans from sources in the Corn Belt while marketing firms in the area ship locally produced beans to export points. Interstate and interregional shipments of soybeans totaled 231 million bushels in 1977 (Table 20), about three-fourths of which originated in the Corn Belt states. The pattern of soybean flows to domestic destinations is illustrated in Figure 7.

Grain marketing firms shipped almost 630 million bushels of soybeans to export regions in 1977 (Table 20). Illinois firms were the most important source for soybeans moving to ports; shipments from Illinois origins totaled over 126 million bushels, or 20 percent of the total. Ohio, Louisiana, Iowa, and Arkansas ranked second through fifth, respectively, in terms of volume shipped to port locations. Each of those states originated more than 50 million bushels.

The destination for shipments to ports from each originating state or region is shown in Table 21. Ports on the Gulf of Mexico were the destinations for 485 million bushels, or 77 percent of the U.S. total. The balance of shipments were shared about equally by Great Lakes and Atlantic ports. Most of the shipments moving to Great Lakes ports originated in states adjacent to these ports and moved relatively short

Table 20. 1977 Shipments of Soybeans to Domestic Destinations and Export Regions by Marketing Firms in Each Originating Region

Originating region	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the region	Outside the region		
	thousands of bushels			
Alabama and Tennessee	74,217	6,275	31,698	112,190
Arkansas	60,647	4,175	56,415	121,237
Delaware, Maryland, N. Carolina, and Virginia	29,855	1,165	7,546	38,566
Florida, Georgia, and S. Carolina	17,394	2,247	6,655	26,296
Illinois	194,849	44,115	126,174	365,138
Indiana	57,788	28,816	44,317	130,921
Iowa	160,952	33,088	64,893	258,933
Kansas and Nebraska	38,204	6,726	5,069	49,999
Kentucky	2,514	8,542	11,414	22,470
Louisiana	17,611	3,377	66,172	87,160
Michigan	530	501	18,091	19,122
Minnesota	74,571	6,453	29,111	110,135
Mississippi	21,938	6,136	33,892	61,966
Missouri	45,999	36,590	42,734	125,323
New Mexico	0	3	0	3
New York, New Jersey, and Pennsylvania	0	4,124	1,263	5,387
North Dakota	0	3,882	0	3,882
Ohio	33,753	21,449	66,556	121,758
Oklahoma	214	3,272	2,250	5,736
South Dakota	0	7,920	85	8,005
Texas	581	108	9,752	10,441
Wisconsin	164	1,793	5,908	7,865
Total volume	831,781	230,757	629,995	1,692,533
Percentage of total volume	49.2	13.6	37.2	100.0

Note: The data in this table include quantities that were reshipped from firms in the Chicago port area (including Milwaukee) to other domestic and port locations but not exports to destinations outside the United States.

Figure 7. Pattern of soybean flows to domestic destinations in 1977.

Figure 8. Pattern of soybean flows to port areas in 1977.

Table 21. 1977 Movements of Soybeans to Export Regions from Individual Regions

Originating region	Export region				Total
	Great Lakes	Atlantic Coast	Gulf Coast	Pacific Coast	
	thousands of bushels				
Alabama and Tennessee	0	0	31,698	0	31,698
Arkansas	0	0	56,415	0	56,415
Delaware, Maryland, N. Carolina, and Virginia	0	7,546	0	0	7,546
Florida, Georgia, and S. Carolina	0	3,490	3,165	0	6,655
Illinois	8,930	4,313	112,931	0	126,174
Indiana	12,657	22,949	8,711	0	44,317
Iowa	3,305	429	60,864	295	64,893
Kansas and Nebraska	0	0	4,634	435	5,069
Kentucky	0	0	11,414	0	11,414
Louisiana	0	0	66,172	0	66,172
Michigan	14,036	4,055	0	0	18,091
Minnesota	0	0	28,572	539	29,111
Mississippi	0	0	33,892	0	33,892
Missouri	0	0	42,734	0	42,734
New York, New Jersey, and Pennsylvania	0	1,263	0	0	1,263
Ohio	29,819	26,077	10,660	0	66,556
Oklahoma	0	0	2,250	0	2,250
South Dakota	0	0	51	34	85
Texas	0	0	9,752	0	9,752
Wisconsin	4,558	0	1,350	0	5,908
Total volume	80,281	70,122	485,265	1,303	629,995
Percentage of total volume	12.7	11.1	77.0	0.2	100.0

Note: Quantities that were reshipped from Chicago and Milwaukee ports to other ports are included in shipments from Illinois and Wisconsin. Export shipments to destinations outside the United States are excluded.

distances. Although some shipments to Atlantic ports originated at nearby points, the predominant origins were located in Ohio and Indiana. Marketing firms in those two states originated about 70 percent of the soybeans shipped to Atlantic ports in 1977.

Firms in the Corn Belt states shipped 264 million bushels to Gulf ports in 1977, amounting to almost 55 percent of the total volume shipped to port elevators in that region. Firms in the south-central region were also important sources, shipping 200 million bushels to Gulf ports (41 percent of the total). Shipments to the Pacific export region totaled only 1.3 million bushels, and most of these movements originated in Iowa, Kansas, Minnesota, and Nebraska. The pattern of soybean flows to port areas is illustrated in Figure 8.

Receipts at Domestic Destinations and Port Areas

In 1977, marketing firms and processors received 272 million bushels of soybeans that originated in other states or regions (Table 22). Of that total, about 231 million bushels were received from grain-handling firms (Table 20). The balance (41 million bushels) was hauled by truck from farms located in adjoining states or regions.

Although Illinois was the leading soybean-producing state in 1977, it also led all others in terms of the volume received from other states or regions. Most of the incoming shipments originated in Indiana, Iowa, and Missouri, and most were transported by truck. The quantity received by Illinois firms from other states excludes quantities received by firms in the Chicago port area, which are reported in Table 23.

Processors and other marketing firms in the Alabama-Tennessee region represent a sizable domestic market for midwestern soybeans.

n 1977 those firms received 43 illion bushels from origins outside ne region. The Alabama-Tennessee egion was the primary domestic estination for soybeans shipped by arge. Firms located in the South tlantic states received large quanties from firms in other states in 977, predominantly by rail. Firms n northwestern Iowa received sizble shipments from Minnesota and outh Dakota. Kansas and Neraska processors purchased subtantial quantities from sources in owa and Missouri.

Of the total volume shipped beween states or regions, 46 percent vas transported by trucks. Railoads and barges carried 32 percent nd 7 percent of the total, respecively, and 15 percent was hauled y farm trucks.

The quantity of soybeans reeived at the various port areas and he modes of transportation used n shipping those volumes are hown in Table 23. Receipts at Great Lakes ports totaled 77 million bushels, 80 percent of which moved rom nearby origins by truck. Atantic ports received 71 million ushels. Eighty-five percent of that volume was transported by rail, mostly as unit-train shipments from Ohio, Indiana, and eastern Illinois.

The Gulf region was a predominant destination for soybeans moving to export points. The importance of the inland waterway system is demonstrated by the fact that 78 percent of the volume received at Gulf ports was transported there by barge. Barge shipments predominated at all Gulf port areas except the North Texas Gulf area, where three-fifths of the soybeans received were transported by truck.

Changes in the Pattern of Domestic Flows

Market flow patterns change over time in response to changes in several factors: the quantities produced

Table 22. Volume of Soybeans Received in Various Domestic Regions from Outside the Region and Percentage Carried by Each Mode of Transportation in 1977

Destination region	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Alabama and Tennessee	43,040	49.2	13.9	33.5	3.4
Arkansas	18,494	23.8	14.3	21.6	40.3
Delaware, Maryland, N. Carolina, and Virginia	20,091	61.3	20.6	0.0	18.1
Florida, Georgia, and South Carolina	15,408	94.5	5.5	0.0	0.0
Illinois	48,834	17.1	63.7	0.0	19.2
Indiana	13,645	13.9	78.8	0.0	7.3
Iowa	19,694	15.3	57.4	0.0	27.3
Kansas and Nebraska	22,836	30.2	47.4	0.0	22.4
Kentucky	10,433	26.0	69.2	0.0	4.8
Louisiana	3,704	39.4	59.3	1.3	0.0
Minnesota	19,673	3.3	86.2	0.0	10.5
Mississippi	9,089	31.7	67.7	0.6	0.0
Missouri	13,343	34.9	65.1	0.0	0.0
Ohio	8,367	0.0	47.0	0.0	53.0
Oklahoma	113	0.0	0.0	0.0	100.0
Texas	3,026	62.7	37.3	0.0	0.0
Wisconsin	1,736	0.0	88.2	0.0	11.8
Total volume	271,526	32.0	46.2	6.8	15.0

Note: These data exclude the receipts at ports (see Table 23).

Table 23. Receipts of Soybeans at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Great Lakes					
Chicago area	29,491	20.9	72.0	4.5	2.6
Toledo area	46,795	8.7	84.2	0.0	7.1
Saginaw area	1,148	0.0	100.0	0.0	0.0
Subtotal	77,434	13.2	79.8	1.7	5.3
Atlantic					
North Atlantic	14,140	91.6	8.4	0.0	0.0
South Atlantic	56,782	83.5	6.1	9.0	1.4
Subtotal	70,922	85.1	6.6	7.2	1.1
Gulf					
East Gulf	71,122	44.5	6.9	47.4	1.2
Louisiana Gulf	387,502	8.1	2.8	89.1	0.0
North Texas Gulf	27,491	38.6	61.4	0.0	0.0
Subtotal	486,115	15.1	6.7	78.0	0.2
Pacific					
Columbia River	565	94.0	6.0	0.0	0.0
Puget Sound	443	42.9	57.1	0.0	0.0
California	295	100.0	0.0	0.0	0.0
Subtotal	1,303	78.0	22.0	0.0	0.0
Total receipts	635,774	22.8	15.6	60.7	0.9

and processed in various regions, the volume and location of exports, and the transportation rate structure. Comparing flow patterns at times can reveal trends occurring in soybean marketing patterns. Previous surveys have been incomplete in their geographical coverage; therefore, it is not possible to fully evaluate all changes that have occurred in flow patterns during recent years. Information available from a 1970 survey of grain movements in three eastern Corn Belt states (Illinois, Indiana, and Ohio), and eight southern states (Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, South Carolina, and Tennessee) provides insights into changes that occurred during the 1970s (*14*).

The manufacturers of poultry feed in the southern states use large volumes of soybean meal, most of which is produced at soybean crushing plants located in the South. Soybean production in the South has expanded rapidly in recent years, and the quantity produced exceeds processing requirements in several southern states. A sizable portion of the crop is produced in an area where it is more practical to ship it to Atlantic and Gulf ports than to local processors (Tables 20 and 21). As a result, processors in the southern states must procure a portion of their supply from outside sources.

In contrast, production in the eastern Corn Belt region greatly exceeds the requirements of local processors, and marketing firms in that region are dependent upon markets outside the local area. An ever-increasing share of these surpluses have been moving to points of export in recent years. Because of its proximity and the existence of a suitable transportation network, however, the South has historically been an important market for soybeans produced in the eastern Corn Belt and the South in recent years.

Soybean movements between eastern Corn Belt and southern states in calendar years 1970 and 1977 are summarized in Table 24. In 1970 a total of 68 million bushels were shipped to southern states from eastern Corn Belt origins. By 1977 the volume had declined slightly to about 62 million bushels. Although the total volume thus remained fairly stable, some notable shifts in trading patterns occurred.

Table 24. Comparison of 1970 and 1977 Interstate Soybean Shipments from Eastern Corn Belt Origins

Destination	Year	
	1970	1977
	thousands of bushels	
North-central states	50,737	31,413
Northeastern states	3,199	0
Western states	0	0
Subtotal	53,936	31,413
Southern states		
Alabama and Tennessee[a]	21,808	27,189
Arkansas	0	4,000
Florida	691	0
Georgia and South Carolina[a]	16,768	12,020
Kentucky	10,760	9,833
Louisiana	0	509
Mississippi	12,502	0
North Carolina and Virginia[a]	5,500	8,696
Subtotal	68,029	62,247
Ports (for export)	162,136	232,511
Total volume	284,101	326,171

Sources: (*9,14*).

Note: Originating states included are Illinois, Indiana, and Ohio.

[a] States were combined to avoid disclosing operations of individual firms.

Table 25. Comparison of the Volume of Soybeans Received in Eight Southern States from Out-of-State Origins in 1970 and 1977

Origin	Year	
	1970	1977
	thousands of bushels	
Southern states[a]	12,621	35,097
Illinois	55,115	30,436
Indiana	4,159	15,180
Iowa	661	696
Kansas	771	1,654
Minnesota	1,112	50
Missouri	1,054	12,451
Nebraska	0	2
Ohio	2,564	8,435
Oklahoma	450	1,200
South Dakota	299	0
Texas	2	75
Total volume	78,808	105,276

Sources: (*9, 14*).

Note: The states included are Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, South Carolina, and Tennessee.

[a] The eight states listed in the note above plus Florida, North Carolina, Virginia, and West Virginia.

In 1970 Illinois was the predominant supplier of soybeans for the southern market, accounting for almost 82 percent of the movements from eastern Corn Belt origins. Illinois's share dropped to 49 percent by 1977. The decline in shipments by Illinois firms was due in part to the fact that Mississippi processors did not procure soybeans from Illinois origins in 1977. The rapid expansion in soybean exports from Gulf ports was also an important factor. The availability of barge transportation makes it advantageous for Illinois firms to ship soybeans to the Gulf; shippers in Indiana and Ohio, on the other hand, have a competitive advantage in southeastern markets served by rail transportation. The volumes shipped from Indiana and Ohio origins to port regions also increased substantially between 1970 and 1977.

The Alabama-Tennessee area was the most significant destination in the South in both years. Shipments from eastern Corn Belt origins totaled 27 million bushels in 1977, and shipments from Illinois accounted for almost 86 percent of the total. Kentucky, Georgia, and South Carolina continued to be important markets for the eastern Corn Belt area, although the volume shipped to those markets declined between 1970 and 1977.

The origins of soybeans shipped to eight southern states in 1970 and 1977 are summarized in Table 25. Receipts of shipments that crossed state lines increased from 79 million bushels in 1970 to 105 million bushels in 1977. Much of that increase can be traced to a sizable increase in interstate movements among southern states. A substantial decline in receipts from Illinois was offset by increased movements from Indiana, Missouri, and Ohio.

The South will likely continue to be an important market for soybeans produced in the Midwest because a sizable proportion of production in the South moves to export regions. In 1977, for example, the eight southern states included in Table 25, plus Florida, shipped 206 million bushels to export points (Table 20).

Developments in Recent Years

The domestic use of soybeans increased from about 1 billion bushels in 1977 to a record 1.2 billion bushels during the 1979–80 marketing year. This relatively small increase probably has had only a minor effect on transportation requirements. In 1977, about 78 percent of the shipments to domestic destinations moved to points within the originating state or multistate region (Table 20). Trucks hauled 80 percent of those shipments. Consequently, most of the increase in movements to domestic points since that time has likely been in the form of short-distance intrastate shipments by truck.

Exports increased more rapidly than domestic use and reached a record 920 million bushels in 1981–82, up from 593 million bushels in 1977. Exports through the Great Lakes ports remained at about the same level as in 1977. Shipments from Atlantic ports were about 25 million bushels above the 1977 level, which would indicate an increase in unit-train shipments from the eastern Corn Belt. Shipments through Gulf ports increased 284 million bushels from the 1977 total. Of that amount, 246 million bushels moved through Louisiana ports. Thus movements by barge have probably increased substantially because barges hauled 89 percent of the soybeans received at Louisiana ports in 1977 (Table 23).

Sorghum Marketing Patterns

Sorghum is the second most important feed grain produced in the United States. Annual production has generally exceeded 700 million bushels in recent years. The production of sorghum is concentrated in the southern Great Plains where rainfall is usually inadequate for corn and soybean production. Even though sorghum is more adaptable to a drier climate, a large portion of the acreage devoted to sorghum production in the Texas panhandle is irrigated. Irrigation is also a common production practice in the western districts of Kansas and Oklahoma. The leading states in sorghum production are Kansas, Missouri, Nebraska, and Texas (Table 26). In 1977 these states produced over 680 million bushels, 87 percent of the total U.S. production. Only four other states produced more than 10 million bushels.

Most of the sorghum produced in the United States is either used for livestock feed or exported to foreign destinations. In 1977 the estimated use in all states totaled 417 million bushels (Table 26), and less than 2 percent of that total was used for purposes other than livestock feed. Kansas and Texas led all states in sorghum utilization; each of those states used more than 100 million bushels. Although a large proportion of the total feed usage occurred in the areas of concentrated sorghum production, livestock feeding industries in Arizona

and California represent important domestic markets for sorghum. Net use in those two states in 1977 totaled 60 million bushels, a large percentage of which was procured from sources outside those states.

About 237 million bushels of sorghum were shipped to foreign destinations in 1977. Texas ports originated about 95 percent of the total. Smaller quantities were exported from Louisiana and California ports. The marketing of U.S. sorghum requires a large transportation capacity, and the very large export demand is the primary determinant of the overall capacity required.

Shipments by State

Grain marketing firms in the United States reported shipping an estimated 671 million bushels of sorghum in 1977 (Table 27). That total excludes the 237 million bushels shipped to foreign destinations by port elevators. A sizable portion of that total is accounted for by the same sorghum being shipped in sequence by several firms. In 1977 about 225 million bushels, or 34 percent of the total disappearance (655 million bushels), were consumed by livestock on sorghum-producing farms. Consequently, the balance of about 430 million bushels was handled by the marketing system. Since the total volume shipped by all firms exceeded that amount by about 240 million bushels, it seems reasonable to assume that this amount approximates the quantity shipped from country elevators to terminal elevators for inspection, storage, and later reshipment to points of consumption and export. Jackson *et al.* reported that terminal markets handled 240 million bushels during the 1975–76 marketing year (*6*).

Shipments to domestic destinations within the originating state accounted for 295 million bushels, or 44 percent of the total (Table 27). Nebraska and Texas led all states

Table 26. Supply and Utilization of Sorghum by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama	0.6	0.7	0.3	1.6	0.0	0.0	0.4	1.2
Arizona	7.1	2.4	12.6	22.1	0.2	0.0	3.2	18.7
Arkansas	3.6	13.1	9.0	25.7	10.3	0.0	6.7	8.7
California	6.2	9.6	30.7	46.5	0.0	1.9	2.6	42.0
Colorado	6.9	8.8	4.8	20.5	6.7	0.0	8.9	4.9
Connecticut	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
Florida	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0
Georgia	0.8	0.7	0.0	1.5	0.0	0.0	0.4	1.1
Illinois	3.5	4.1	1.4	9.0	3.3	0.0	2.8	2.9
Indiana	0.9	1.2	0.0	2.1	0.0	0.0	0.9	1.2
Iowa	2.6	2.4	0.2	5.2	3.3	0.0	1.6	0.3
Kansas	139.6	235.6	17.5	392.7	97.3	0.0	193.9	101.5
Kentucky	1.0	1.5	0.1	2.6	0.8	0.0	1.1	0.7
Louisiana	0.7	0.6	12.8	14.1	0.1	7.9	0.5	5.6
Minnesota	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
Mississippi	0.8	0.7	0.7	2.2	0.0	0.0	0.4	1.8
Missouri	21.9	67.9	13.5	103.3	28.1	0.0	33.2	42.0
Nebraska	101.1	147.0	0.5	248.6	85.0	0.0	134.9	28.7
New Mexico	5.8	11.7	0.0	17.5	4.2	0.0	5.5	7.8
North Carolina	2.4	2.4	0.0	4.8	0.0	0.0	1.7	3.1
Ohio	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
Oklahoma	12.6	21.5	4.8	38.9	5.8	0.0	18.6	14.5
South Carolina	0.3	0.2	0.0	0.5	0.0	0.0	0.1	0.4
South Dakota	3.2	16.8	0.0	20.0	0.1	0.0	14.3	5.6
Tennessee	0.9	1.0	0.9	2.8	0.8	0.0	0.7	1.3
Texas	169.5	230.4	149.6	549.5	16.2	225.9[a]	183.7	123.7
Utah	0.2	0.0	0.3	0.5	0.0	0.0	0.1	0.4
Virginia	0.3	0.4	0.0	0.7	0.0	0.0	0.2	0.5
Washington	0.0	0.0	2.2	2.2	0.0	1.6	2.7	−2.1
Total volume	492.5	780.9	262.4	1,535.8	262.4	237.3	619.1	417.0

Sources: (*9, 16, 17*).

[a] Includes 2,780,000 bushels that were shipped to Mexico by rail from Texas. The balance was handled by Texas Gulf ports.

In terms of intrastate domestic movements, accounting for 67 percent of the total (Figure 9). Kansas was third with 48 million bushels. In contrast, Kansas led all states in terms of the volume shipped to interstate domestic markets. Forty-two percent of the 130 million bushels shipped to interstate domestic destinations originated in that state. Nebraska firms ranked second in volume, with shipments to interstate domestic markets totaling 30 million bushels.

Texas was the leading origin of sorghum destined for export regions. In 1977, firms in that state shipped 116 million bushels to export points (Table 27). Nebraska and Kansas ranked second and third, respectively, in volume shipped to export regions. Firms in those states shipped 98 million bushels. Missouri firms shipped about 15 million bushels for export, placing that state a distant fourth. The flow pattern is illustrated in Figure 10.

The distribution pattern for the 130 million bushels that moved across state boundaries to domestic markets is presented in Table 28. Kansas, the leading origin of interstate domestic movements, shipped 54 million bushels. Texas and Missouri were the major destinations for Kansas sorghum, receiving 17 and 11 million bushels, respectively. Arizona and California were major markets in the West. Kansas firms shipped 13.5 million bushels to destinations in those states. These states were also important markets for Texas and Colorado firms, which shipped over 20 million bushels to those destinations. Missouri and Nebraska firms shipped sorghum to all the major destinations shown in Table 28; Kansas and Texas, however, were the primary domestic markets for shippers in those states. Texas was the primary destination for shipments from Oklahoma and New Mexico.

Figure 9. Pattern of sorghum flows to domestic destinations in 1977.

Table 27. 1977 Shipments of Sorghum to Domestic Destinations and Export Regions by Marketing Firms in Each Originating State or Port Area

Originating state or port area	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the state	In other states		
	thousands of bushels			
States				
Alabama	57	0	0	57
Arizona	12,757	71	94	12,922
Arkansas	10,599	1,537	8,740	20,876
California	3,859	0	0	3,859
Colorado	0	6,688	0	6,688
Florida	76	0	246	322
Georgia	54	0	0	54
Illinois	376	1,094	2,217	3,687
Iowa	183	371	1,941	2,495
Kansas	48,413	54,227	42,856	145,496
Kentucky	0	32	0	32
Louisiana	579	51	194	824
Mississippi	82	0	0	82
Missouri	14,256	12,961	14,689	41,906
Nebraska	91,016	29,659	55,109	175,784
New Mexico	5,447	4,086	122	9,655
North Carolina	64	0	0	64
Oklahoma	430	3,612	2,186	6,228
South Dakota	0	126	0	126
Tennessee	0	32	815	847
Texas	106,901	16,023	116,172[a]	239,096
Port Area				
Louisiana Gulf	22	0	0	22
Total volume	295,171	130,570	245,381	671,122
Percentage of total volume	44.0	19.4	36.6	100.0

Note: The data in this table exclude export shipments to overseas destinations by ship.

[a] Includes 2,780,000 bushels shipped to Mexico by rail.

Receipts at Domestic Destinations and Port Areas

The volume of sorghum received and the share hauled by competing modes of transportation are shown for selected states in Table 29. Even though the domestic consumption of sorghum is less concentrated than production from a geographic standpoint, eight states received 95 percent of the interstate movements in 1977. Texas and California were the principal destinations; interstate receipts in those states totaled 64 million bushels. Railroads hauled 75 percent of all the sorghum received in the major states. The proportion of receipts carried by rail ranged from 59 percent in Missouri to 99 percent in California. Trucks hauled the balance. In areas where sorghum was not a major crop, producers often hauled their sorghum by farm truck to firms in adjacent states. The most prominent examples of this type of movement were sales by Iowa farmers to Missouri firms and sales by Kentucky farmers to Illinois firms.

Receipts at ports in 1977 totaled 243 million bushels, 98 percent of which was received at Gulf ports (Table 30). The North Texas port area (in the Houston-Galveston area) ranked first, with receipts totaling 134 million bushels. Railroads hauled 73 percent of the sorghum moving to that port area. The South Texas port area (in the Brownsville-Corpus Christi area) ranked second in terms of volume; receipts there totaled 93 million bushels. Again, shipments were received predominantly by rail, but the volume trucked to that port area was sizable. Texas firms shipped 113 million bushels to these port areas, 79 percent of which was hauled by trucks. Shippers in other states relied on railroads for movements to Texas ports. Louisiana ports received 11 million bushels of sorghum, 62 percent of which was transported by barge. Arkansas and Missouri were the main origins for sorghum shipped to Louisiana ports, originating 80 percent of the total. California ports were the only port facilities to receive sorghum directly from farms.

Figure 10. Pattern of sorghum flows to port areas in 1977.

Table 28. Domestic Distribution Patterns for Sorghum Shipped Between Major Originating and Destination States in 1977

Major originating states	Major domestic destination states								Total volume shipped
	Ariz.	Ark.	Calif.	Kan.	Mo.	Okla.	Tex.	Other	
	millions of bushels								
Arizona	NA	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Colorado	1.0	0.0	4.0	0.0[a]	0.0	0.0	1.6	0.0	6.6
Kansas	5.2	5.0	8.3	NA	11.4	4.3	17.3	2.7	54.2
Missouri	0.1	2.9	2.1	3.3	NA	0.0[a]	4.5	0.1	13.0
Nebraska	1.6	0.3	3.3	13.7	0.6	0.2	4.7	4.8	29.2
New Mexico	0.5	0.0	0.0	0.0	0.0	0.0	3.6	0.0	4.1
Oklahoma	0.0	0.0	0.5	0.2	0.0	NA	2.9	0.0	3.6
Texas	4.2	0.0	10.9	0.0	0.0	0.3	NA	0.6	16.0
Other	1.0	0.2	0.0	0.0[a]	1.6	0.0	0.5	NA	3.3
Total volume received	13.6	8.4	29.2	17.2	13.6	4.8	35.1	8.2	130.1

[a] Less than 50,000 bushels.

NA = not applicable.

Table 29. Volume of Sorghum Received in Various States from Origins Outside the State and Percentage Carried by Each Mode of Transportation in 1977

Domestic destination state	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Alabama	313	74.4	25.6	0.0	0.0
Arizona	12.558	76.6	23.4	0.0	0.0
Arkansas	8,445	81.6	18.4	0.0	0.0
California	29,135	99.2	0.8	0.0	0.0
Colorado	3,534	75.2	24.8	0.0	0.0
Connecticut	167	100.0	0.0	0.0	0.0
Illinois	1,424	5.8	15.0	0.0	79.2
Iowa	229	58.1	41.9	0.0	0.0
Kansas	17,535	76.2	22.8	0.0	1.0
Kentucky	86	100.0	0.0	0.0	0.0
Louisiana	1,833	97.2	2.8	0.0	0.0
Minnesota	231	87.9	12.1	0.0	0.0
Mississippi	671	45.2	54.8	0.0	0.0
Missouri	13,470	58.9	34.1	0.0	7.0
Nebraska	325	4.3	7.1	0.0	88.6
Nevada	3	100.0	0.0	0.0	0.0
New Mexico	12	0.0	100.0	0.0	0.0
Ohio	125	100.0	0.0	0.0	0.0
Oklahoma	4,820	60.6	39.4	0.0	0.0
Tennessee	883	76.5	18.1	0.0	5.4
Texas	35,091	64.7	35.3	0.0	0.0
Utah	289	100.0	0.0	0.0	0.0
Total volume	131,179	75.5	22.5	0.0	2.0

Note: These data exclude the receipts at ports (see Table 30).

Table 30. Receipts of Sorghum at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Gulf					
Louisiana	11,126	38.2	0.2	61.6	0.0
North Texas	134,425	72.6	25.9	1.5	0.0
South Texas	93,300	54.5	45.5	0.0	0.0
Subtotal	238,851	63.9	32.4	3.7	0.0
Pacific					
Columbia River	15	100.0	0.0	0.0	0.0
Puget Sound	2,196	15.1	84.9	0.0	0.0
California	2,165	71.1	0.0	0.0	28.9
Subtotal	4,376	43.1	42.6	0.0	14.3
Total receipts	243,227	63.5	32.6	3.6	0.3

Oat Marketing Patterns

Oats are the third most important feed grain produced in the United States. Annual production has averaged about 600 million bushels in recent years. In 1977 oat production in the U.S. totaled 753 million bushels. Minnesota and South Dakota produced 302 million bushels, two-fifths of U.S. production (Table 31). Iowa, North Dakota, and Wisconsin were the only other states that produced 60 million bushels or more in 1977.

The volume of oats that must be transported is relatively small in comparison with other grains. Oats

Table 31. Supply and Utilization of Oats by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama	0.3	1.2	2.2	3.7	1.4	0.0	0.7	1.6
Arizona	0.1	0.0	0.2	0.3	0.0	0.0	0.0	0.3
Arkansas	0.5	3.5	0.4	4.4	2.6	0.0	0.5	1.3
California	1.2	4.6	6.3	12.1	0.4	0.0	1.7	10.0
Colorado	2.2	1.5	0.1	3.8	0.0	0.0	1.3	2.5
Connecticut	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.6
Florida	0.4	0.5	2.4	3.3	0.3	0.0	0.7	2.3
Georgia	1.2	2.8	1.7	5.7	0.0	0.0	1.1	4.6
Idaho	1.8	2.6	0.0	4.4	0.2	0.0	1.7	2.5
Illinois	14.0	20.4	1.1	35.5	2.1	0.0	13.6	19.8
Indiana	6.6	6.4	2.9	15.9	2.1	0.0	5.4	8.4
Iowa	64.5	82.3	3.4	150.2	8.4	0.0	63.1	78.7
Kansas	7.2	9.4	0.9	17.5	0.0	0.0	6.8	10.7
Kentucky	1.0	0.3	5.2	6.5	0.6	0.0	0.2	5.7
Louisiana	0.1	0.4	7.3	7.8	1.2	0.5	0.3	5.8
Maine	0.9	1.8	1.0	3.7	0.2	0.0	1.1	2.4
Maryland	0.8	1.1	0.1	2.0	0.0	0.0	0.7	1.3
Michigan	12.1	18.7	0.0	30.8	6.4	0.0	12.2	12.2
Minnesota	71.9	161.8	19.7	253.4	29.3	8.6	127.6	87.9
Mississippi	0.4	0.6	2.4	3.4	0.5	0.0	0.4	2.5
Missouri	5.4	7.3	6.3	19.0	0.9	0.0	6.8	11.3
Montana	7.7	5.0	0.0	12.7	1.1	0.0	6.1	5.5
Nebraska	21.8	40.6	0.9	63.3	9.1	0.0	31.4	22.8
Nevada	0.2	0.2	0.0	0.4	0.0	0.0	0.3	0.1
New Jersey	0.3	0.4	0.0	0.7	0.0	0.0	0.2	0.5
New Mexico	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1
New York	10.6	15.4	0.1	26.1	0.4	0.0	10.5	15.2
North Carolina	1.8	3.2	1.6	6.6	0.4	0.0	1.1	5.1
North Dakota	44.7	60.0	0.0	104.7	11.8	0.0	56.8	36.1
Ohio	15.6	21.8	2.1	39.5	9.1	0.0	15.1	15.3
Oklahoma	3.2	6.0	6.7	15.9	0.0	0.0	3.7	12.2
Oregon	3.2	5.2	0.5	8.9	5.5	0.0	3.6	−0.2
Pennsylvania	11.3	18.5	15.0	44.8	0.1	0.0	11.6	33.1
South Carolina	0.9	2.5	0.4	3.8	1.0	0.0	0.8	2.0
South Dakota	44.8	140.4	0.0	185.2	13.1	0.0	105.2	66.9
Tennessee	0.8	0.6	3.4	4.8	0.7	0.0	0.6	3.5
Texas	7.3	24.0	3.0	34.3	0.0	0.0	9.4	24.9
Utah	0.5	0.6	0.4	1.5	0.3	0.0	0.4	0.8
Vermont	0.0	0.0	2.0[a]	2.0	0.0	0.0	0.0	2.0
Virginia	0.8	1.3	1.9	4.0	0.1	0.0	0.8	3.1
Washington	1.3	1.5	0.8	3.6	0.2	0.2	0.9	2.3
West Virginia	0.9	0.5	0.0	1.4	0.0	0.0	0.7	0.7
Wisconsin	40.0	76.0	9.1	125.1	2.2	0.1	58.4	64.4
Wyoming	2.1	1.9	0.1	4.1	0.0	0.0	1.5	2.6
Total volume	412.5	752.8	112.2[a]	1,277.5	111.7	9.4	565.0	591.4

Sources: (*7, 16, 17*).

[a] Includes 0.5 million bushels imported from Canada.

are less dense (bulkier) than other grains and are therefore more expensive to transport. Consequently, in 1977 only 112 million bushels, or about 15 percent of the amount produced, moved in interstate commerce (Table 31). For the same reason, the quantity exported in 1977 totaled only 9 million bushels.

In contrast with other major feed grains, over 60 percent of the oats produced in 1977 were used for seed and livestock feed on the farms where they were produced. That quantity represented over 80 percent of the total disappearance for seed and feed purposes. About 20 percent of the oats used for livestock feed are processed by the feed manufacturing industry. In 1975 Vosloh reported that the feed manufacturing industry used 107 million bushels of oats (*20*). Food processors used about 43 million bushels in 1977.

The estimated use in each state is shown in Table 31. Four states (Iowa, Minnesota, South Dakota, and Wisconsin) accounted for 50 percent of the total volume used. Minnesota led all states in utilization of oats; usage in that state approached 88 million bushels in 1977. Inventory levels increased substantially in Minnesota and South Dakota that year.

Shipments by State

Grain marketing firms in the United States reported shipping 227 million bushels of oats in 1977 (Table 32), excluding the 9.4 million bushels shipped to overseas destinations by port elevators. A sizable portion of that total is accounted for by the oats being shipped in sequence by several firms. Minneapolis and Duluth-Superior are important terminal markets for oats. These locations function as major storage and transshipment points for oats produced in Minnesota, North Dakota, and South Dakota.

Table 32. 1977 Shipments of Oats to Domestic Destinations and Export Regions by Marketing Firms in Each Originating State or Port Area

Originating state or port area	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the state	In other states		
	thousands of bushels			
States				
Alabama	1,333	1,387	0	2,720
Arizona	215	0	0	215
Arkansas	779	2,641	0	3,420
California	714	0	0	714
Colorado	0	24	0	24
Florida	1,809	268	0	2,077
Georgia	1,028	23	0	1,051
Idaho	0	240	0	240
Illinois	4,249	1,209	92	5,550
Indiana	343	208	0	551
Iowa	15,252	6,573	1,589	23,414
Kentucky	0	596	0	596
Louisiana	711	20	0	731
Maine	106	194	0	300
Maryland	0	2	0	2
Michigan	1,816	6,082	0	7,898
Minnesota	51,487	23,756	8,042	83,285
Mississippi	3,259	524	0	3,783
Missouri	981	882	0	1,863
Montana	0	783	354	1,137
Nebraska	18,142	9,110	0	27,252
New York	190	114	0	304
North Carolina	1,165	384	0	1,549
North Dakota	0	6,837	4,968	11,805
Ohio	5,960	9,018	0	14,978
Oklahoma	35	0	0	35
Oregon	39	5,528	2,867	8,434
Pennsylvania	853	51	0	904
South Carolina	725	857	0	1,582
South Dakota	40	11,413	1,265	12,718
Tennessee	186	681	0	867
Texas	0	18	0	18
Utah	0	351	0	351
Vermont	9	0	0	9
Virginia	0	70	0	70
Washington	0	152	0	152
Wisconsin	1,313	607	1,032	2,952
Wyoming	5	12	0	17
Port Areas				
Duluth-Superior	212	1,376	107	1,695
Chicago-Milwaukee	140	766	14	920
Louisiana Gulf	0	1,229	0	1,229
Total volume	113,096	93,986	20,330	227,412
Percentage of total volume	49.7	41.3	9.0	100.0

Note: The data in this table exclude shipments by port elevators to foreign destinations by water.

Shipments to domestic destinations within the originating state accounted for 50 percent of the total volume. About two-thirds of this total was shipped by truck, and the balance was shipped by rail. Minnesota accounted for a substantial share of intrastate domestic movements, and shipments within that state were divided equally between rail and truck transportation. Iowa and Nebraska were the only other states with sizable intrastate shipments.

Shipments to domestic markets in other states totaled 94 million bushels in 1977 (Table 32). In contrast to intrastate movements, the railroad was the predominant mode of transportation for interstate movements, carrying 49 percent of the total volume. The shares moving by truck and barge were 39 percent and 12 percent, respec-

Figure 11. Pattern of oat flows to domestic destinations in 1977.

Table 33. 1977 Movements of Oats to Export Regions from Individual States and Port Areas

Originating state or port area	Export region				Total
	Great Lakes	Atlantic Coast	Gulf Coast	Pacific Coast	
	thousands of bushels				
States					
Illinois	92	0	0	0	92
Iowa	37	0	1,552	0	1,589
Minnesota	4,583	0	3,459	0	8,042
Montana	354	0	0	0	354
North Dakota	4,756	0	0	212	4,968
Oregon	0	0	0	2,867	2,867
South Dakota	1,265	0	0	0	1,265
Wisconsin	756	0	420	0	1,176
Port Areas					
Duluth-Superior	107	0	0	0	107
Chicago-Milwaukee	14	0	0	0	14
Total volume	11,964	0	5,431	3,079	20,474
Percentage of total volume	58.4	0.0	26.5	15.1	100.0

Note: The data in this table include quantities that moved directly from farmers to port elevators and that were excluded from Table 32.

ively. Minnesota was by far the eading source of interstate shipnents. Firms in that state originated ver 25 percent of the total volume. Nebraska, Ohio, and South Dakota vere also important sources; together they originated 31 percent f the total volume. The pattern of nterstate flows to domestic destinations is illustrated in Figure 11.

Shipments to port regions were relatively small in comparison to those of other feed grains, totaling only 20 million bushels in 1977. Less than half of that amount was actually exported. Movements to the ports from each originating state are summarized in Table 33. Great Lakes ports were the primary destination region, receiving 60 percent of the shipments destined for export regions. Most of these movements originated in Minnesota, North Dakota, and South Dakota. Over 5 million bushels were shipped to Gulf ports in 1977. Almost all of those shipments moved from dis-

Table 34. Volume of Oats Received in Various States from Origins Outside the State and Percentage Carried by Each Mode of Transportation in 1977

Originating state	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Alabama	2,249	2.1	10.0	87.9	0.0
Arizona	164	0.0	100.0	0.0	0.0
Arkansas	362	95.9	4.1	0.0	0.0
California	6,300	15.9	84.1	0.0	0.0
Colorado	51	88.2	11.8	0.0	0.0
Connecticut	594	100.0	0.0	0.0	0.0
Florida	2,362	33.4	7.7	58.9	0.0
Georgia	1,726	46.5	50.5	0.0	3.0
Illinois	431	13.2	86.8	0.0	0.0
Indiana	2,757	0.5	57.8	0.0	41.7
Iowa	3,379	54.5	44.4	0.0	1.1
Kansas	45	82.2	17.8	0.0	0.0
Kentucky	5,195	5.6	22.3	35.5	36.6
Louisiana	2,179	16.5	83.5	0.0	0.0
Maine	975	100.0	0.0	0.0	0.0
Maryland	64	54.7	0.0	0.0	45.3
Massachusetts	13	0.0	100.0	0.0	0.0
Michigan	3	0.0	100.0	0.0	0.0
Minnesota	13,215	68.6	29.6	0.0	1.8
Mississippi	2,089	25.8	9.0	0.0	65.2
Missouri	6,331	43.8	46.1	10.1	0.0
Nebraska	900	24.7	37.3	0.0	38.0
New Jersey	45	0.0	100.0	0.0	0.0
New York	131	8.4	7.6	90.0	0.0
North Carolina	1,641	67.5	32.5	0.0	0.0
Ohio	2,062	42.0	35.5	7.3	15.2
Oklahoma	6,101	18.1	81.9	0.0	0.0
Oregon	454	0.0	17.6	0.0	82.4
Pennsylvania	14,966	74.2	23.6	0.0	2.2
South Carolina	379	77.3	21.4	0.0	1.3
Tennessee	2,897	28.9	8.1	62.4	0.6
Texas	2,955	60.8	39.2	0.0	0.0
Utah	403	59.6	40.4	0.0	0.0
Vermont	2,047	81.7	17.7	0.0	0.6
Virginia	1,942	89.8	10.2	0.0	0.0
Washington	631	24.9	75.1	0.0	0.0
Wisconsin	9,093	46.7	52.0	0.0	1.3
Wyoming	100	58.0	42.0	0.0	0.0
Total receipts	97,231	46.4	39.0	9.5	5.1

Note: These data exclude the receipts at ports (see Table 35).

tant origins in Iowa and Minnesota. Oregon firms were the primary sources for oats shipped to Pacific ports.

Receipts at Domestic Destinations and Port Areas

In 1977, firms at various domestic destinations reported receipts of 97 million bushels of oats from origins in other states (Table 34). Minnesota and Pennsylvania were the only states reporting receipts in excess of 10 million bushels. The majority of the shipments to these markets were transported by rail. States receiving more than 6 million bushels were California, Missouri, Oklahoma, and Wisconsin, and most of that volume was carried by trucks. Overall, about 10 percent of interstate receipts wer hauled by barges. Alabama, Florid Kentucky, and Tennessee were th principal destinations for thes barge shipments.

There was also great diversity i the mode of transportation used t convey oats to various ports (Tabl 35). About two-thirds of the oat moving to Duluth-Superior (th leading Great Lakes port area moved by rail. A sizable portion o these receipts are stored in transi and reshipped by rail to other mar kets at a later date (see Table 32) In contrast, Louisiana ports rely o barge transportation for a substan tial portion of their receipts. Truck are the dominant mode used i moving oats to ports in the Pacific Northwest. The pattern of oat flows to various port regions is illustrated in Figure 12.

Figure 12. Pattern of oat flows to port areas in 1977.

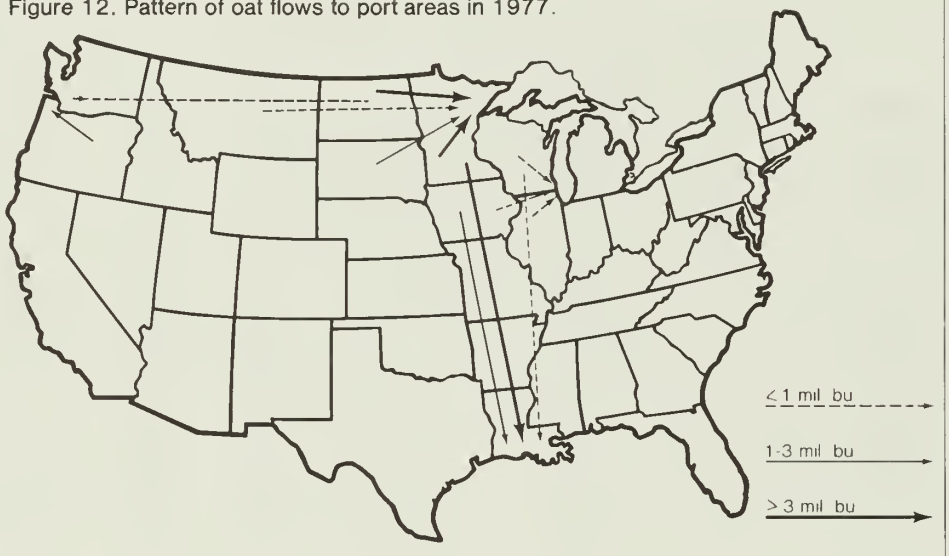


Table 35. Receipts of Oats at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Great Lakes					
Duluth-Superior	10,961	67.9	32.1	0.0	0.0
Chicago-Milwaukee	1,003	29.1	48.3	8.2	14.4
Subtotal	11,964	64.6	33.5	0.7	1.2
Gulf					
East Gulf	275	100.0	0.0	0.0	0.0
Louisiana Gulf	5,156	31.2	0.8	68.0	0.0
Subtotal	5,431	34.7	0.8	64.5	0.0
Pacific					
Columbia River	2,867	4.8	95.2	0.0	0.0
Puget Sound	212	14.6	85.4	0.0	0.0
Subtotal	3,079	5.5	94.5	0.0	0.0
Total receipts	20,474	47.8	34.0	17.5	0.7

Barley Marketing Patterns

Barley is normally considered a feed grain. Market flows are complicated, however, by the fact that different varieties are produced to meet the needs of specific users. About 50 percent of the acreage planted in the United States is seeded with varieties suitable for malting. Following harvest, barley that meets the grade requirements for four subclasses — six-rowed blue malting barley, six-rowed malting barley, two-rowed malting barley, and choice two-rowed malting barley — is segregated throughout the storage and marketing processes, and these subclasses usually command a premium price. Additional information on barley classes

Table 36. Supply and Utilization of Barley by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				millions of bushels				
Alabama	1.5	4.2	1.6	7.3	0.0	0.0	2.6	4.7
California	18.6	53.2	23.0	94.8	0.0	7.3	22.2	65.3
Colorado	15.3	14.2	0.2	29.7	2.5	0.0	14.2	13.0
Connecticut	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.5
Delaware	0.4	1.0	1.0	2.4	1.5	0.0	0.5	0.4
Georgia	1.0	0.3	0.0	1.3	0.0	0.0	0.1	1.2
Idaho	28.0	51.7	0.8	80.5	21.4	0.0	29.2	29.9
Illinois	1.1	0.4	4.1	5.6	0.4	0.0	1.0	4.2
Indiana	0.2	0.3	0.0	0.5	0.0	0.0	0.2	0.3
Iowa	0.0	0.0	1.9	1.9	0.0	0.0	0.0	1.9
Kansas	1.3	2.6	0.0	3.9	0.0	0.0	1.7	2.2
Kentucky	0.3	1.2	4.4	5.9	0.0	0.0	0.4	5.5
Maryland	1.7	3.3	0.4	5.4	1.6	1.2	1.8	0.8
Michigan	0.6	1.1	0.1	1.8	0.0	0.0	0.6	1.2
Minnesota	44.6	55.1	73.8	173.5	40.0	43.2	50.3	40.0
Missouri	0.1	0.3	0.1	0.5	0.0	0.0	0.2	0.3
Montana	28.6	52.2	0.0	80.8	23.6	0.0	41.8	15.4
Nebraska	1.4	1.9	0.5	3.8	0.6	0.0	1.6	1.6
Nevada	0.2	1.5	0.1	1.8	0.1	0.0	0.4	1.3
New Jersey	0.2	0.6	0.6	1.4	0.1	0.0	0.2	1.1
New Mexico	0.4	1.3	0.0	1.7	0.0	0.0	0.4	1.3
New York	0.2	0.4	5.1	5.7	0.0	0.0	1.3	4.4
North Carolina	0.9	2.2	0.1	3.2	0.3	0.0	0.7	2.2
North Dakota	59.8	98.7	0.0	158.5	64.8	0.0	86.2	7.5
Ohio	0.3	0.6	1.0	1.9	0.0	0.0	0.4	1.5
Oklahoma	1.6	4.2	1.4	7.2	0.0	0.0	2.6	4.6
Oregon	5.2	8.9	8.0	22.1	3.0	4.0	6.8	8.3
Pennsylvania	2.4	5.0	3.7[a]	11.1	0.3	0.0	2.5	8.3
South Carolina	0.2	0.8	0.0	1.0	0.0	0.0	0.2	0.8
South Dakota	7.9	26.9	0.0	34.8	11.3	0.0	18.9	4.6
Tennessee	0.1	0.2	0.0	0.3	0.0	0.0	0.2	0.1
Texas	0.5	3.4	0.0	3.9	0.0	0.3	0.7	2.9
Utah	6.0	6.8	7.3	20.1	10.7	0.0	5.5	3.9
Vermont	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
Virginia	1.7	4.4	1.6	7.7	0.2	2.2	1.4	3.9
Washington	12.2	9.5	16.5	38.2	1.1	13.8	8.1	15.2
West Virginia	0.4	0.4	0.0	0.8	0.0	0.0	0.4	0.4
Wisconsin	23.0	1.6	33.4[b]	58.0	2.7	2.2	20.0	33.1
Wyoming	4.3	7.4	0.0	11.7	2.0	0.0	3.9	5.8
Total volume	271.2	427.8	191.3	890.3	188.2	74.2	329.2	298.7

Sources: (*4, 16, 17*).

[a] Includes 1.7 million bushels imported from Canada.

[b] Includes 1.4 million bushels imported from Canada.

and subclasses has been published elsewhere (2, 3).

Production of the six-rowed malting subclasses is concentrated in Minnesota, North Dakota, and South Dakota. In 1977 the proportion of total acreage seeded to malting varieties in these states ranged from 60 percent in South Dakota to 95 percent in Minnesota (12). The two-rowed malting varieties are grown in the western states. Idaho and Montana were the leading producers in 1977. The proportions seeded to malting varieties in those states were 42 percent and 51 percent, respectively. Two-rowed malting barley was also grown in Colorado, Oregon, Washington, and Wyoming. Although California ranked third in barley production in 1977, about 99 percent of its acreage was seeded to feed varieties.

A 1977 survey of producers revealed that 43 percent of malting barley was sold directly to maltsters and brewers. Another 10 percent was marketed through grain dealers. Local elevators handled only 47 percent of producer sales (19). In contrast, elevators handled 63 percent of producer sales of feed barley, grain dealers purchased 17 percent, and the balance was sold to other farmers and to ranchers and commercial feedlots.

The amount of barley used for malting, which has increased steadily over time, totaled 130 million bushels in 1977. About 145 million bushels were used for livestock feed that year, and about two-thirds of that amount was used on the farms where it was produced. Seed and food uses accounted for 18 million and 6 million bushels, respectively, and domestic use for all purposes totaled 299 million bushels. Estimates of net use in the various states were developed using the survey data on interstate movements in conjunction with production and stock data. These estimates are shown in Table 36.

Table 37. 1977 Shipments of Barley to Domestic Destinations and Export Regions by Marketing Firms in Each Originating State or Port Area

Originating state or port area	Volume shipped to domestic destinations		Volume shipped to export regions	Total
	Within the state	In other states		
	thousands of bushels			
States				
Arizona	1,780	0	0	1,780
California	35,640	0	127	35,767
Colorado	0	2,472	0	2,472
Delaware	357	298	1,050	1,705
Georgia	0	26	0	26
Idaho	4,718	13,908	6,936	25,562
Illinois	23	0	0	23
Maryland	362	1,087	1,259	2,708
Michigan	270	0	0	270
Minnesota	27,793	25,467	18,246	71,506
Montana	4,484	17,133	6,493	28,110
Nebraska	22	447	192	661
Nevada	0	102	0	102
New Jersey	0	59	0	59
New Mexico	0	12	0	12
New York	941	0	0	941
North Carolina	880	0	292	1,172
North Dakota	39	30,002	34,824	64,865
Oklahoma	198	0	0	198
Oregon	1,980	457	4,601	7,038
Pennsylvania	306	208	95	609
South Carolina	46	4	0	50
South Dakota	10	7,737	3,332	11,079
Utah	0	10,682	41	10,723
Virginia	368	112	1,202	1,682
Washington	3,914	91	8,256	12,261
Wisconsin	5	2,704	1,278	3,987
Wyoming	1,015	1,956	0	2,971
Port Areas				
Duluth-Superior	2,003	12,507	67	14,577
Chicago-Milwaukee	0	234	0	234
South Atlantic	355	0	0	355
Columbia River	0	0	3	3
U.S. total volume	87,509	127,705	88,294	303,508
Percentage of total volume	28.8	42.1	29.1	100.0

Note: The data in this table exclude shipments by port elevators to foreign destinations by water.

The leading states in terms of quantity used were California, Minnesota, and Wisconsin. The large California demand reflects the needs of livestock feeding firms as well as malting firms. The demands in Minnesota and Wisconsin reflect utilization by malting plants located in those states. Other states that required sizable quantities of malting barley were Colorado, Illinois, New York, and Washington. The relatively large quantities demanded in Idaho and Montana were used for livestock feed and seed.

Shipments by State

Grain marketing firms in the United States reported shipping about 304 million bushels of barley in 1977 (Table 37), excluding the 74 million

Figure 13. Pattern of barley flows to domestic destinations in 1977.

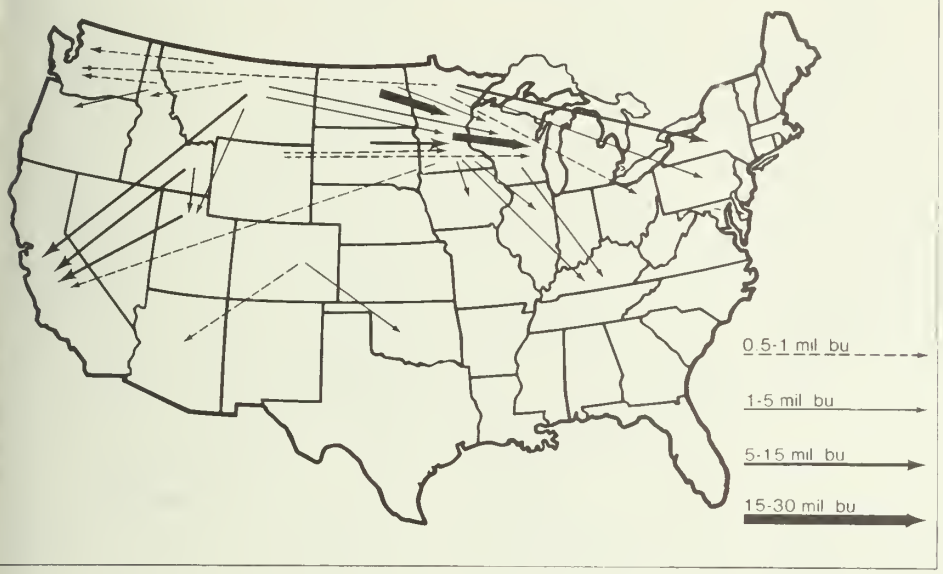


Table 38. 1977 Movements of Barley to Export Regions from Individual States and Port Areas

Origin	Export region				Total
	Great Lakes	Atlantic Coast	Gulf Coast	Pacific Coast	
	thousands of bushels				
States					
California	0	0	0	7,628	7,628
Delaware	0	1,050	0	0	1,050
Idaho	115	0	0	6,821	6,936
Maryland	0	1,259	0	0	1,259
Minnesota	17,916	0	0	330	18,246
Montana	60	0	0	6,433	6,493
Nebraska	192	0	0	0	192
North Carolina	0	345	0	0	345
North Dakota	34,213	0	0	611	34,824
Oregon	0	0	0	4,601	4,601
Pennsylvania	0	95	0	0	95
South Dakota	3,252	0	4	76	3,332
Utah	0	0	0	41	41
Virginia	0	1,202	0	0	1,202
Washington	0	0	0	8,256	8,256
Wisconsin	1,278	0	0	0	1,278
Port Areas					
Duluth-Superior	67	0	0	0	67
Columbia River	0	0	0	3	3
Canada	1,402	0	0	0	1,402
Total volume	58,495	3,951	4	34,800	97,250
Percentage of total volume	60.1	4.1	0.0	35.8	100.0

Note: The data in this table include quantities that moved directly from farmers to port elevators.

bushels exported to other countries (Table 36). That total includes about 50 million bushels that were shipped in sequence by several firms. Minneapolis and Duluth-Superior are important storage and transshipment points in the marketing channels for barley. In 1977, marketing firms in Minneapolis received and reshipped about 35 million bushels. Terminal firms at the Duluth-Superior port reshipped almost 15 million bushels to domestic destinations. Most of these shipments probably moved directly to maltsters and food processors. These data suggest that maltsters likely procured the balance of their needs directly from farmers and country shipping points.

Shipments to domestic destinations within the originating state accounted for over 87 million bushels, or 29 percent of the total. Intrastate movements were very large in California and Minnesota. Movements within those two states totaled 63 million bushels. The California movements were predominantly feed barley, whereas the Minnesota firms were dealing primarily with malting barley.

Interstate movements to domestic destinations totaled 128 million bushels in 1977, and five states and one port area originated more than 10 million bushels each. North Dakota led all states with 30 million bushels, 89 percent of which moved to Minnesota destinations. North Dakota firms shipped an additional 33 million bushels to the Duluth-Superior port area. Minnesota ranked second in terms of volume shipped to other states, and Wisconsin maltsters were the primary market. Idaho, Montana, and Utah were other important origins for interstate movements. It should be noted that terminals in the Salt Lake City area served as transshipment points for sizable volumes that were trucked in from Idaho and Montana and reshipped to California by rail.

The pattern of interstate barley flows to domestic destinations is illustrated in Figure 13.

Barley movements to various export regions totaled 97 million bushels in 1977 (Table 38). This total includes about 7.6 million bushels that moved directly from farms and 1.4 million bushels that were imported from Canadian origins and are excluded from the data in Table 37. The Great Lakes and Pacific regions were predominant in handling barley destined for the export market. Minnesota and North Dakota were the primary origins of barley moving to Great Lakes ports. The origins of barley moving to Pacific ports were more diverse: five states originated 4 million bushels or more. A sizable portion of the Pacific total was drawn from nearby origins in California, Oregon, and Washington. Idaho and Montana were also important sources. Small quantities moved from origins in Minnesota and North Dakota. A substantial portion of the 26 million bushels shipped to port cities located on the Columbia River was used by maltsters. Only 63 percent of the volume received at Columbia River ports was exported. Consequently, most of the barley that moved from distant origins in Minnesota, Montana, and North Dakota was probably high-quality malting barley demanded by maltsters in the Vancouver, Washington, area. The pattern of barley flows to port areas is illustrated in Figure 14.

Receipts at Domestic Destinations and Port Areas

Information about the modes of transportation used to convey barley in interstate commerce is important for many policy and investment decisions. The volume received in various states from origins outside those states and the percentage transported by each mode of transportation are shown in Table 39. Domestic markets for

Figure 14. Pattern of barley flows to port areas in 1977.

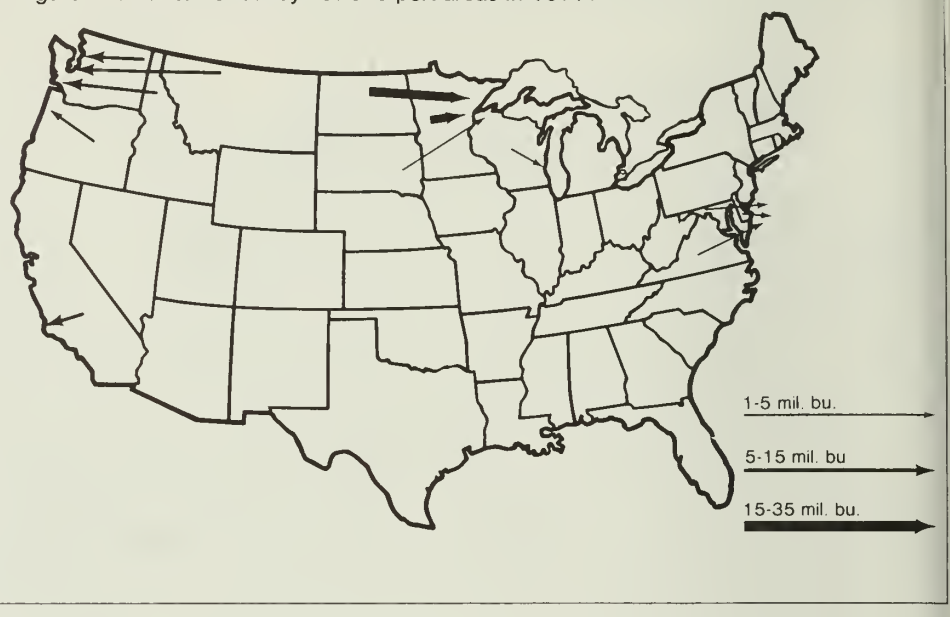


Table 39. Volume of Barley Received in Various States from Origins Outside the State and Percentage Carried by Each Mode of Transportation in 1977

Originating state	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Arizona	1,639	25.0	75.0	0.0	0.0
California	22,830	51.0	49.0	0.0	0.0
Colorado	227	81.5	18.5	0.0	0.0
Connecticut	448	100.0	0.0	0.0	0.0
Delaware	956	0.0	75.1	0.0	24.9
Florida	40	100.0	0.0	0.0	0.0
Idaho	785	6.8	93.2	0.0	0.0
Illinois	1,248	100.0	0.0	0.0	0.0
Iowa	1,924	1.3	98.7	0.0	0.0
Kentucky	4,354	100.0	0.0	0.0	0.0
Maryland	182	0.0	26.4	0.0	73.6
Michigan	94	100.0	0.0	0.0	0.0
Minnesota	37,179	95.5	4.5	0.0	0.0
Missouri	142	100.0	0.0	0.0	0.0
Nebraska	547	68.0	0.0	0.0	32.0
Nevada	97	0.0	100.0	0.0	0.0
New Jersey	645	0.0	100.0	0.0	0.0
New York	5,123	34.4	1.0	64.6	0.0
North Carolina	49	89.8	10.2	0.0	0.0
Ohio	950	100.0	0.0	0.0	0.0
Oklahoma	1,380	50.4	49.6	0.0	0.0
Oregon	4,513	79.0	7.6	0.0	13.4
Pennsylvania	3,711	91.8	8.0	0.0	0.2
South Carolina	10	0.0	60.0	0.0	40.0
South Dakota	1	0.0	100.0	0.0	0.0
Utah	7,328	23.9	76.1	0.0	0.0
Vermont	78	100.0	0.0	0.0	0.0
Washington	2,307	65.1	34.9	0.0	0.0
Wisconsin	31,947	98.2	1.2	0.0	0.6
Wyoming	32	9.4	90.6	0.0	0.0
Total receipts	130,766	76.2	20.3	2.5	1.0

Note: These data exclude receipts at ports (see Table 40).

barley were highly concentrated in three states. Receipts exceeded 30 million bushels in both Minnesota and Wisconsin, and California ranked third. Together, these states received 70 percent of all barley shipped across state lines.

Railroads were the predominant mode of transportation used in domestic barley movements, accounting for 76 percent of the volume in 1977. In fact, that mode was dominant in all but two markets receiving 2 million bushels or more. One exception was New York, where lake vessels and barges transported 65 percent of receipts. These barge movements originated at the Duluth-Superior port area and moved across the Great Lakes to Buffalo. Firms in the Duluth-Superior area also shipped over 11 million bushels to domestic destinations by railroads. The other exception was the Utah market, where about 5.6 million bushels were received by truck from Idaho and Montana. Truck movements across state lines to domestic interstate markets totaled 26 million bushels in 1977, about 20 percent of the total. Trucks and railroads shared about equally in transporting the large volume moving to California destinations.

Table 40. Receipts of Barley at Various Port Areas and Percentage Carried by Each Mode of Transportation in 1977

Export region and port area	Quantity received	Mode of transportation			
		Rail	Truck	Barge	Farm truck
	thousands of bushels	*percentage transported*			
Great Lakes					
Duluth-Superior	52,923	31.6	68.4	0.0	0.0
Chicago-Milwaukee	5,572	73.7	1.1	25.2	0.0
Subtotal	58,495	35.6	62.0	2.4	0.0
Atlantic					
South Atlantic	3,951	6.6	58.7	33.4	1.3
Gulf					
North Texas Gulf	4	50.0	50.0	0.0	0.0
Pacific					
Columbia River	26,066	80.5	13.0	6.5	0.0
Puget Sound	912	100.0	0.0	0.0	0.0
California	7,822	3.4	0.7	0.0	95.9
Subtotal	34,800	63.7	9.9	4.9	21.5
Total receipts	97,250	44.5	43.2	4.5	7.8

The importance of each mode of transportation in moving barley to ports is shown in Table 40. Railroads and trucks carried about equal shares. The differences among the various ports are noticeable. Of all ports, those in the Duluth-Superior area handled the largest volume, and 68 percent of the receipts at that port area were transported by truck. The Columbia River port area ranked second in terms of volume, and railroads hauled 80 percent of the total volume received there. California ports relied primarily on movements directly from farms within the state to meet their export demands. Almost 8 million bushels were shipped directly from farms to port elevators in that state.

Rye Marketing Patterns

Rye is grown commercially in 29 states; however, production is concentrated primarily in the north-central region. In 1977 five states produced almost 63 percent of the total U.S. crop (Table 41). South Dakota produced the greatest amount, followed by Minnesota and North Dakota. Nebraska was also a major producer in the north-central area. Georgia was the only state outside this area that produced more than one million bushels.

Rye is used primarily for food products, seed, alcoholic beverages, and livestock feed. Domestic use for all purposes in each state was estimated using the flow data in conjunction with published data on inventories and production. These estimates are shown in Table 41. In 1977 about 16 million bushels were used for all purposes. Kentucky led all states in utilization, and distillers used a large proportion of that total in the production of distilled spirits. Illinois and Indiana are other states where distillers used sizable quantities of rye. Utilization for human food is concentrated in Minnesota and New York, where about 90 percent of the U.S. rye milling capacity is located. Utilization in the remaining states is primarily for livestock feed and seed.

Shipments and Receipts by State

The high-quality rye demanded by distillers and rye millers is produced primarily in Minnesota, North Dakota, and South Dakota. The mar-

keting of this grain is focused on the terminal markets in Minnesota. Terminal elevators in that state handle, store, and reship a large proportion of the rye moving through commercial marketing channels. Shipments and receipts are shown by origin and destination in Table 42.

Over 3 million bushels of rye moved from origins in North Dakota and South Dakota to destinations in Minnesota in 1977. About two-thirds of those shipments moved by rail; the balance moved by truck. The primary destinations were the terminal markets in Minneapolis and Duluth-Superior. A substantial portion of the volume handled by firms in the Duluth-Superior area was reshipped by laker vessels to rye millers in Buffalo, New York. This flow was supplemented with rail shipments from the Minneapolis area during the winter months when ice prevented the shipment of grain over the Great Lakes waterway.

In total, marketing firms in Minnesota reported shipping 7.3 million bushels of rye in 1977, and firms in the Minneapolis area handled about 70 percent of the total. About 75 percent of the volume shipped by Minnesota firms moved to destinations in other states (Fig-

Table 41. Supply and Utilization of Rye by State in 1977

State	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Ending stocks	Net use
			thousands of bushels				
Alabama	0	0	10	10	10	0	0
California	0	0	109	109	0	0	109
Connecticut	0	0	89	89	0	0	89
Colorado	141	80	0	221	0	80	141
Delaware	11	125	0	136	0	11	125
Florida	0	0	10	10	0	0	10
Georgia	434	1,995	0	2,429	0	344	2,085
Illinois	82	330	552	964	89	73	802
Indiana	99	260	547	906	0	80	826
Iowa	114	116	0	230	0	45	185
Kansas	48	180	0	228	0	71	157
Kentucky	217	108	3,082	3,407	0	295	3,112
Louisiana	0	0	188	188	0	0	188
Maryland	24	232	0	256	0	21	235
Michigan	97	456	0	553	0	108	445
Minnesota	2,727	2,436	3,271	8,434	5,337	1,742	1,355
Missouri	9	162	0	171	0	22	149
Montana	0	0	0	0	108	0	−108
Nebraska	302	1,050	6	1,358	250	402	706
New Jersey	77	232	0	309	0	138	171
New York	146	279	833	1,258	0	87	1,171
North Carolina	61	399	0	460	0	111	349
North Dakota	1,769	2,080	0	3,849	1,788	1,806	255
Ohio	57	160	0	217	0	88	129
Oklahoma	173	646	0	819	0	250	569
Oregon	127	125	88	340	1	68	271
Pennsylvania	53	372	0	425	0	70	355
South Carolina	123	620	0	743	10	54	679
South Dakota	1,593	2,842	0	4,435	1,386	2,938	111
Tennessee	15	46	127	188	0	8	180
Texas	16	400	8	424	0	62	362
Virginia	34	350	0	384	0	44	340
Washington	28	60	0	88	0	19	69
Wisconsin	251	364	0	615	0	226	389
Wyoming	62	38	0	100	0	29	71
Total volume	8,890	16,543	8,920	34,353	8,979	9,292	16,082

Sources: (*4, 16, 17*).

ıre 15). Over 3 million bushels were shipped to Kentucky, primarily to distilling firms. Illinois and Indiana were also important destinations for rye originating in Minnesota, and more than 500,000 bushels were shipped to each of those states.

The railroad was the dominant mode of transportation in rye distribution, hauling 69 percent of the volume shipped in 1977. Barge transportation was dominant only for movements to New York and Louisiana. Overall, barge shipments accounted for 12 percent of the volume. Trucks transported a sizable volume only from the Dakotas to Minnesota and within the state of Minnesota.

Figure 15. Pattern of rye flows to domestic destinations in 1977.

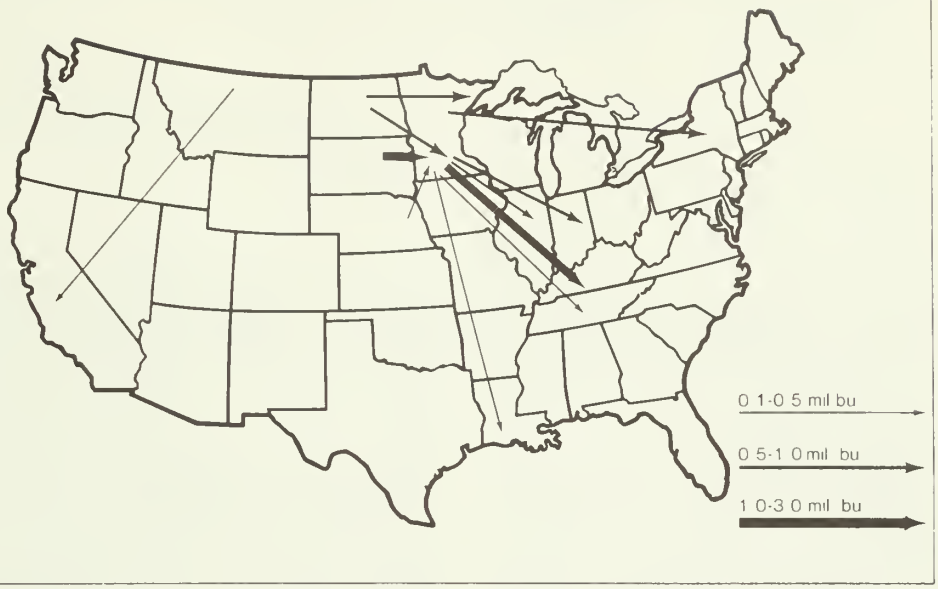


Table 42. Shipments of Rye and Percentage Carried by Each Mode of Transportation in 1977

Originating state	Destination state	Volume shipped	Mode of transportation			
			Rail	Truck	Barge	Farm truck
		thousands of bushels	*percentage transported*			
Alabama	Florida	10	0.0	100.0	0.0	0.0
Georgia	Georgia	12	0.0	0.0	0.0	0.0
Illinois	Connecticut	89	100.0	0.0	0.0	0.0
Kentucky	Kentucky	50	0.0	100.0	0.0	0.0
Minnesota	Illinois	552	100.0	0.0	0.0	0.0
	Indiana	547	100.0	0.0	0.0	0.0
	Kentucky	3,316	85.4	0.0	14.6	0.0
	Louisiana	188	0.0	0.0	100.0	0.0
	Minnesota	1,779	71.2	28.6	0.0	0.2
	New York	833	19.3	0.0	80.7	0.0
	Tennessee	127	100.0	0.0	0.0	0.0
	Texas	8	100.0	0.0	0.0	0.0
	Subtotal	7,350	74.0	7.7	18.3	0.0
Montana	California	108	0.0	100.0	0.0	0.0
Nebraska	Iowa	61	0.0	0.0	0.0	100.0
	Minnesota	189	100.0	0.0	0.0	0.0
	Nebraska	368	62.2	37.2	0.0	0.6
	Subtotal	618	67.6	22.2	0.0	10.2
North Dakota	Minnesota	1,696	58.5	41.5	0.0	0.0
	Nebraska	4	0.0	100.0	0.0	0.0
	Oregon	88	11.4	88.6	0.0	0.0
	Subtotal	1,788	56.1	43.9	0.0	0.0
Oregon	California	1	0.0	100.0	0.0	0.0
South Carolina	Alabama	10	100.0	0.0	0.0	0.0
South Dakota	Minnesota	1,386	68.9	31.1	0.0	0.0
	South Dakota	29	0.0	100.0	0.0	0.0
	Subtotal	1,415	67.5	32.5	0.0	0.0
Total volume		11,451	100.0	18.5	11.7	0.7

Flaxseed Marketing Patterns

The production of flaxseed in the United States is heavily concentrated in Minnesota, North Dakota, and South Dakota, which together produce about 99 percent of the total amount grown (Table 43). The primary use of flaxseed is for processing into linseed oil and linseed meal. Flaxseed production has declined over the years as the development of synthetic paints has reduced the demand for linseed oil. The volume exported is generally quite small and totaled only 1 million bushels in 1977.

Shipments and Receipts by State

In 1977, grain marketing firms in the three major producing states reported shipping more than 11 million bushels, including the amount that was exported (Table 44). Because flaxseed processing plants are located near the areas of concentrated production, the volume moving long distances is not large. Only North Dakota and South Dakota reported interstate shipments in 1977. Those shipments were destined for the terminal markets at Minneapolis and Duluth-Superior. North Dakota firms also identified a small volume moving to the Pacific Northwest; however, the exact destination could not be determined. Firms interviewed in the Pacific Northwest did not report receiving any flaxseed. The small volume and the few firms involved in the transactions made it difficult to capture all movements in a sample comprising less than the total population.

Because of the relatively short distances involved, trucks were the predominant mode of transportation used in moving flaxseed. Overall, trucks hauled 64 percent of the total volume shipped. Truck ship-

Table 43. Supply and Utilization of Flaxseed by State in 1977

State or region	Beginning stocks	Production	Interstate receipts	Total available	Interstate shipments	Export shipments	Ending stocks	Net use
				thousands of bushels				
Minnesota	3,887	3,190	6,718	13,795	0	991	3,516	9,288
Montana	140	35	0	175	0	0	47	128
North Dakota	4,982	7,000	0	11,982	5,023	0	2,526	4,433
South Dakota	1,932	3,965	0	5,897	1,749	0	1,123	3,025
Texas	0	90	0	90	0	0	16	74
Pacific Northwest	0	0	54	54	0	0	0	54
Total volume	10,941	14,280	6,772	31,993	6,772	991	7,228	17,002

Sources: (*4, 16, 17*).

Table 44. Shipments of Flaxseed and Percentage Carried by Each Mode of Transportation in 1977

Originating state	Destination state	Volume shipped	Mode of transportation			
			Rail	Truck	Barge	Farm truck
		thousands of bushels	*percentage transported*			
Minnesota	Minnesota	3,236	33.7	66.2	0.0	0.1
	Duluth-Superior	188	0.0	100.0	0.0	0.0
	Subtotal	3,424	31.8	68.2	0.0	0.0
North Dakota	Minnesota	4,214	26.5	73.5	0.0	0.0
	Washington	54	0.0	100.0	0.0	0.0
	Duluth-Superior	755	32.1	67.9	0.0	0.0
	Subtotal	5,023	27.1	72.9	0.0	0.0
South Dakota	Minnesota	1,670	35.1	64.9	0.0	0.0
	Duluth-Superior	79	17.7	82.3	0.0	0.0
	Subtotal	1,749	34.3	65.7	0.0	0.0
Duluth-Superior	Export	991	0.0	0.0	100.0	0.0
Total volume		11,187	27.3	63.9	8.8	0.0

nents accounted for 73 percent of he total volume shipped from North Dakota and 66 percent of he total from South Dakota. Rail hipments from North Dakota toaled approximately 1.4 million bushels, whereas South Dakota firms shipped only 600,000 bushels by rail.

Duluth-Superior was the only port area that handled flaxseed in 1977. North Dakota was the primary source of flaxseed moving to that port area. Smaller quantities were shipped from Minnesota and South Dakota. Again, trucks were the primary means of transporting flaxseed to that port area.

The Demand for Transportation in Grain Marketing

The above information on marketng patterns for individual grains is useful to grain firms in identifying marketing opportunities. It is also useful in evaluating state and federal transportation policies. However, information on the overall demand for transportation equipment and the proportion transported by each mode is usually of greater interest to policy makers. An overview of the transportation requirements for shipping grain without regard to the type of grain shipped is presented in this section.

The data for individual commodities were converted from bushels to tons and aggregated for each mode of transportation. These data include information on all eight grains discussed in previous sections. All tabular data in this section are expressed in 100-ton units, the standard capacity of the hopper car used in shipping grain by railroad. The jumbo box barge has a capacity of 1,500 tons, so about 15 units would represent one barge load. About four trucks (semitrailers) would be required to haul a 100-ton unit of grain.

Shipments and Receipts by State

In 1977, grain marketing firms in the United States reported shipping about 300 million tons of grain to various destinations, excluding shipments to overseas destinations by port elevators. This total exceeds the volume of grain sold from U.S. farms because, as discussed previously, a sizable volume of grain is shipped in sequence by several firms as it moves from production areas to points of use or export. About 43 percent of the amount shipped moved to domestic destinations within the state in which it originated. These domestic movements within each state are summarized by mode of transportation in Table 45. These data exclude movements to port elevators located in the same state. Trucking was the predominant mode of transportation, carrying almost 69 percent of the total volume. Rail shipments accounted for 23 percent of the total, and most of the balance was shipped back to local farmers. Very little of the grain shipped within state boundaries was conveyed by barge. Even though intrastate shipments moved relatively short distances, the volume hauled was more than double the volume shipped to domestic markets across state lines.

The largest volume of intrastate movements occurred in Illinois, totaling 24 million tons. Intrastate shipments in Iowa, Minnesota, and Nebraska exceeded 10 million tons. The farm truck data of Table 45 underestimate total shipments to farmers since several states did not include sales to farmers in their survey responses. Iowa, however, led all states in this type of movements, reporting shipments of almost 6 million tons of grain by Iowa firms to farmers within the state.

In contrast to intrastate domestic movements, the predominant mode of transportation used for shipping to domestic markets in other states was the railroad. Trains carried almost 37 million tons, or 60 percent of the total volume shipped across state lines to destinations other than ports (Table 46). In total, almost 61 million tons were shipped to domestic markets across state lines. Over half of the rail tonnage originated in Illinois, Indiana, Kansas, and Nebraska.

A large proportion of rail movements from Illinois and Indiana were destined for northeastern and southern feed grain markets. Almost half of the rail movements originating in Kansas were destined for Missouri and Texas markets. California, Colorado, and Kansas were the principal destinations for grain shipped by rail from Nebraska, each of these states receiving more than 1 million tons.

In contrast, trucks were the primary mode of transportation for grain shipped from Iowa to domestic markets in other states. Trucks transported over 60 percent of the grain shipped from that state. Illinois, Minnesota, and Wisconsin were the primary destinations. Sizable quantities of grain moved by truck from Indiana to destinations in Illinois and Ohio. Marketing firms

Table 45. 1977 Intrastate Shipments of Grain to Domestic Markets from Each State by Mode of Transportation

Originating state or port area	Mode of transportation				Total
	Rail	Truck	Barge	Farm truck	
	hundreds of tons				
States					
Alabama	507	3,718	175	1,016	5,416
Arizona	205	4,729	0	1,150	6,084
Arkansas	9,730	20,273	0	174	30,197
California	1,342	18,299	0	0	19,641
Colorado	891	3,169	0	0	4,060
Delaware	0	2,203	0	0	2,203
Florida	2,399	683	0	32	3,114
Georgia	203	7,345	0	3,183	10,731
Idaho	266	4,968	0	0	5,234
Illinois	16,149	221,289	0	6,462	243,900
Indiana	1,266	73,963	0	528	75,757
Iowa	13,703	118,140	0	59,192	191,035
Kansas	68,918	26,464	55	0	95,437
Kentucky	1,883	2,621	39	0	4,543
Louisiana	0	6,435	0	0	6,435
Maine	16	0	0	0	16
Maryland	0	2,370	0	0	2,370
Michigan	852	7,495	0	0	8,347
Minnesota	37,524	87,753	0	11,821	137,098
Mississippi	2,016	6,356	0	139	8,511
Missouri	20,672	20,480	1,112	0	42,264
Montana	5,423	869	0	0	6,292
Nebraska	41,407	62,237	0	15,152	118,796
New York	890	779	0	50	1,719
North Carolina	1,173	15,235	0	0	16,408
North Dakota	2,240	0	0	0	2,240
Ohio	2,287	40,096	0	0	42,383
Oklahoma	26,815	10,510	0	0	37,325
Oregon	42	4,075	14	0	4,131
Pennsylvania	0	10,776	0	0	10,776
South Carolina	179	808	0	1,049	2,036
South Dakota	0	16	0	0	16
Tennessee	579	4,664	0	606	5,849
Texas	25,687	59,235	0	0	84,922
Utah	1,486	357	0	0	1,843
Vermont	0	0	0	2	2
Virginia	26	172	173	635	1,006
Washington	2,489	10,154	0	0	12,643
Wisconsin	0	1,933	0	686	2,619
Wyoming	125	119	0	30	274
Delaware, Maryland, N. Carolina, and Virginia	1,091	7,757	105	0	8,953
Florida, Georgia, and S. Carolina	2,977	2,237	0	0	5,214
Alabama and Tennessee	3,644	17,775	837	0	22,256
Kansas and Nebraska	3,093	8,353	0	0	11,446
Port Areas					
Duluth-Superior	24	0	0	0	24
Chicago-Milwaukee	1,009	189	235	0	1,433
South Atlantic	0	26	0	0	26
Total volume	301,228	897,125	2,745	101,597	1,302,695
Percentage of total volume	23.1	68.9	0.2	7.8	100.0

Note: The data in this table exclude movements of grain to port locations.

in Illinois, Missouri, Nebraska, and North Dakota made extensive use of trucks for shipping grain. Truck movements from each of these states exceeded 1 million tons in 1977. In the national pattern of grain shipments, trucks accounted for about 31 percent of the volume moving across state boundaries to domestic markets. Less than 10 percent of the total was shipped by barge and farm truck.

The volume of grain received in each state from other states is shown in Table 47. The domestic market for grain is dispersed throughout the United States, and 1977 receipts in 23 states totaled more than 1 million tons. Minnesota led all states, with interstate receipts of 6 million tons, reflecting the importance of terminal markets in that state for grain produced in North Dakota and South Dakota. Illinois ranked second in terms of interstate receipts; about 70 percent of the volume received originated in Indiana and Iowa. All states in the Corn Belt region received over 1 million tons of grain. Except for Missouri, these shipments were predominantly transported by truck from adjacent states. Railroads were the dominant mode for movements to Missouri, and the Kansas City area received large volumes of grain by rail from Kansas and Nebraska.

The South, with its large grain-consuming animal industry, represents an important domestic market for feed grains. The flour-milling and soybean-processing industries in that region also use large volumes of wheat and soybeans. In 1977 interstate grain receipts in 10 of 14 southern states exceeded 1 million tons. Receipts in Alabama, Arkansas, Georgia, Tennessee, and Texas actually exceeded 2 million tons. Railroads were the primary mode of transportation for moving grain to southern markets. Although the railroads were dominant, barges moved large quantities up the Tennessee River to destinations in Alabama and Tennessee.

Large livestock feeding operations in California make that state a major domestic market for grain in the West. In 1977 almost 4.5 million tons of grain were shipped to California from other states. Those flows were dominated by rail shipments of corn and sorghum from distant origins in Nebraska and Texas. The flour-milling industry in Buffalo, New York, processes large quantities of wheat, and as a result that state is the leading market for grain in the East. A large portion of the grain shipped to that state moves across the Great Lakes by barges and lake vessels. Rail movements to New York destinations become more important during the winter months when the Great Lakes are frozen over.

Shipments to Ports

The export market for U.S. grains has become increasingly important in recent years. Consequently, the volume of grain moving to U.S. ports has become an important determinant of the demand for transportation services for U.S. grain. In 1977 almost 108 million tons of grain were shipped to U.S. ports (Table 48). Illinois and Iowa were dominant origins for export grain, and shipments originating in those states accounted for 31 percent of the total volume moving to port areas. Indiana, Kansas, Minnesota, North Dakota, Ohio, and Texas each shipped more than 5 million tons of grain to U.S. ports. Marketing firms in these eight states shipped over 73 million tons of grain to ports in 1977. Twelve other states each shipped 1 million tons or more to ports.

Railroads and barges were the dominant modes of transportation for shipping grain to ports in 1977, accounting for 43 percent and 42 percent of the total, respectively (Table 48). The balance was hauled by trucks. Railroads were generally the dominant mode for the long-

Table 46. 1977 Interstate Shipments of Grain to Domestic Markets from Each State by Mode of Transportation

Originating state or port area	Mode of transportation				Total
	Rail	Truck	Barge	Farm truck	
	hundreds of tons				
States					
Alabama	316	428	14	0	758
Arizona	113	715	0	0	828
Arkansas	362	2,246	0	0	2,608
Colorado	6,221	3,086	0	0	9,307
Delaware	0	1,930	0	0	1,930
Florida	11	31	0	0	42
Georgia	1,653	1,008	0	0	2,661
Idaho	3,273	2,723	0	0	5,996
Illinois	40,518	16,644	9,846	6	67,014
Indiana	39,175	19,703	3,281	60	62,219
Iowa	16,044	31,029	470	1,585	49,128
Kansas	46,335	9,250	2,640	47	58,272
Kentucky	10,251	3,144	807	0	14,202
Louisiana	3	1,114	0	0	1,117
Maine	31	0	0	0	31
Maryland	45	3,093	0	0	3,138
Michigan	5,095	2,158	0	0	7,253
Minnesota	15,311	7,710	7,359	108	30,488
Mississippi	479	2,086	15	0	2,580
Missouri	16,559	10,887	2,798	0	30,244
Montana	6,490	7,763	0	0	14,253
Nebraska	64,872	10,894	618	5,930	82,314
Nevada	81	0	0	0	81
New Jersey	0	322	0	0	322
New Mexico	814	1,130	0	0	1,944
New York	655	198	0	0	853
North Carolina	279	597	0	0	876
North Dakota	24,872	11,084	0	0	35,956
Ohio	21,699	6,492	871	0	29,062
Oklahoma	6,431	4,906	300	0	11,637
Oregon	697	1,934	0	0	2,631
Pennsylvania	77	808	0	0	885
South Carolina	468	466	0	15	949
South Dakota	10,063	7,819	0	0	17,882
Tennessee	2,398	821	0	0	3,219
Texas	10,553	1,832	0	0	12,385
Utah	2,476	1,023	0	0	3,499
Virginia	16	246	0	0	262
Washington	13	794	0	0	807
Wisconsin	968	5,904	0	15	6,887
Wyoming	568	91	0	1	660
New Jersey, New York, and Pennsylvania	0	1,234	0	0	1,234
Delaware, Maryland, N. Carolina, and Virginia	94	255	0	0	349
Florida, Georgia, and S. Carolina	382	289	0	0	671
Alabama and Tennessee	1,475	406	0	0	1,881
Kansas and Nebraska	1,190	820	0	0	2,010

continued

Table 46 — continued

Originating state or port area	Mode of transportation				Total
	Rail	Truck	Barge	Farm truck	
	hundreds of tons				
Port Areas					
Duluth-Superior	6,844	5	14,689	0	21,538
Chicago-Milwaukee	1,188	237	27	0	1,452
Toledo	0	272	0	0	272
South Atlantic	398	752	174	0	1,324
Louisiana Gulf	174	530	1,260	0	1,964
Columbia River	99	14	0	0	113
Total volume	368,129	188,923	45,169	7,767	609,988
Percentage of total volume	60.3	31.0	7.4	1.3	100.0

Note: The data in this table exclude movements to ports (see Table 48).

distance movements originating in the northern plains and mountain regions. Trains also hauled large volumes from the eastern Corn Belt to Atlantic ports and from the southern plains to Texas ports.

Barges were the dominant mode used to ship grain from states along the Mississippi River to port facilities in Louisiana. The Mississippi River is the vital link that connects the Midwest production area to the large export market for U.S. grain. Illinois is the leading state by far in terms of volume shipped by barge. Barge shipments from that state totaled 18.5 million tons in 1977. Some of that volume is handled by barge-loading facilities located on the Mississippi River. A majority of barge shipments from Illinois, however, originated at loading points along the Illinois River, a tributary to the Mississippi River (see Appendix Table 2). Iowa and Minnesota ranked second and third, with barge shipments totaling 5.3 and 4.3 million tons, respectively. In the Northwest, sizable volumes were shipped by barge from Idaho, Oregon, and Washington to Columbia River port facilities.

Although trucks hauled a smaller volume of grain to ports, they were used extensively in short-distance movements to Great Lakes and Texas ports. Of even greater value, however, is the role played by the trucking industry in moving grain from farms and country elevators to barge-loading facilities on the nation's waterways. Trucks also play a vital role in the assembly of grain from various country points to unit-train-loading facilities scattered throughout the Midwest. Thus the task of moving grain from farms to U.S. ports requires a coordinated effort by all three modes of transportation.

The volumes of grain received at various U.S. ports and the modes of transportation used to convey them are presented in Table 49. The very large export demand is focused on the Gulf region. In 1977, ports in that region received almost 68 million tons of grain, or 62 percent of the total volume received at all port regions. Port elevators in the Louisiana Gulf area led all others, with receipts totaling 45 million tons. Firms in that area were dependent upon a steady flow of grain by barge down the Mississippi River. North Texas Gulf ports ranked second in volume, with receipts of 15.6 million tons in 1977.

Great Lakes port facilities handled 15.7 million tons in 1977, or 14 percent of the total. All port areas in this region except Duluth-Superior depended upon truck shipments from adjacent states. Atlantic ports handled about 13 percent of the total volume, and most of that grain moved by unit trains from the eastern portion of the Corn Belt. Although Pacific ports handled only 11 percent of the total volume in 1977, Columbia River ports ranked fourth among all port areas in 1977, with receipts totaling 8.8 million tons. California ports offer an interesting contrast to other ports in that a majority of the grain handled was received directly from California farms.

Developments in Recent Years

The demand for transportation services to move grain varies from year to year in response to changes in the volume of grain produced and consumed in the United States as well as the volume exported. These changes also affect the proportion carried by each mode of transportation since barge transportation is available only to certain production regions and ports. Because data on the volume hauled by all modes are not available for recent years, it is not possible to fully evaluate all changes that have occurred. Data on barge movements and exports are published periodically, however, and can be used to make some inferences about the nature of changes that have occurred.

Barge Movements of Grain. The results of the 1977 survey revealed that almost 94 percent of all barge shipments were destined for U.S. ports, excluding the 1.5 million tons that moved from Duluth-Superior to destinations in New York and Ohio via the Great Lakes. Thus any increases that have occurred in barge shipments would correspond to increased exports from Mississippi and Columbia River export terminals.

Barge shipments originating on various segments of the inland waterway system since 1976–77 are

summarized in Table 50. A record 58.5 million tons were moved by barges during the 1981–82 shipping season, a 35 percent increase since the 1976–77 shipping season. About 85 percent of the increase corresponded to areas serving Gulf ports, and shipments from origins on the Snake and Columbia Rivers accounted for 15 percent of the increase. Although smaller in terms of total volume, barge loadings of wheat and barley on the Snake-Columbia River system have increased 64 percent since 1976–77, and the increase was steady throughout the period.

Barge movements from origins along the Mississippi River increased dramatically through the 1980–81 shipping season and then declined slightly during 1981–82 following the drouth-induced decrease in the corn crop in 1980. Because wheat movements from the upper reaches of the Mississippi River were fairly stable, increases on those segments reflect increases in the volume of corn and soybeans transported (see Appendix Tables 1 through 6 for a breakout by commodity). It is interesting to note that barge movements from the Memphis area exceeded 7 million tons in 1981–82, an increase of 53 percent from the 1980–81 level. This change reflects the sizable increase in the amount of soft red winter wheat that was produced in the Delta states and shipped to the Gulf for export.

A substantial increase in movements of wheat, corn, and soybeans on the Ohio River occurred in 1981–82. The increased movements of corn and soybeans on this segment partially offset the reduced shipments of these commodities from origins along the Iowa and northern Illinois area of the Mississippi River as well as origins along the Illinois River. These data dramatically illustrate the effects of the severe drouth of 1980 in the western Corn Belt on the typical grain flow patterns. They also illustrate

Table 47. 1977 Receipts of Grain in Each State from Origins Outside the State by Mode of Transportation

Destination state	Mode of transportation				Total
	Rail	Truck	Barge	Farm truck	
	hundreds of tons				
States					
Alabama	11,983	2,185	10,025	0	24,193
Arizona	3,932	1,525	0	44	5,501
Arkansas	24,214	3,357	1,200	2,235	31,006
California	37,940	6,845	0	31	44,816
Colorado	11,899	1,138	0	0	13,037
Connecticut	2,901	0	0	0	2,901
Delaware	0	2,369	0	964	3,333
Florida	5,449	657	1,761	0	7,867
Georgia	21,007	819	0	239	22,065
Idaho	50	2,918	0	0	2,968
Illinois	13,376	25,216	724	7,085	46,401
Indiana	2,520	9,004	1,071	7,626	20,221
Iowa	3,339	8,128	0	1,659	13,126
Kansas	17,333	7,487	0	999	25,819
Kentucky	4,084	4,249	429	4,374	13,136
Louisiana	8,220	2,279	871	9	11,379
Maine	3,890	4	0	0	3,894
Maryland	171	1,949	33	704	2,857
Massachusetts	121	2	0	0	123
Michigan	192	53	0	0	245
Minnesota	34,905	24,298	0	2,574	61,777
Mississippi	11,519	5,546	1,548	0	18,613
Missouri	23,492	12,146	1,309	264	37,211
Montana	0	10	0	0	10
Nebraska	2,295	3,067	0	1,576	6,938
Nevada	51	25	0	0	76
New Hampshire	44	8	0	0	52
New Jersey	105	270	0	0	375
New Mexico	184	3	0	0	187
New York	11,630	121	14,273	0	26,024
North Carolina	9,989	900	0	0	10,889
North Dakota	418	308	0	0	726
Ohio	688	6,909	815	7,505	15,917
Oklahoma	8,889	5,679	0	33	14,601
Oregon	2,474	665	0	203	3,342
Pennsylvania	7,651	5,214	0	1,056	13,921
South Carolina	4,828	383	0	38	5,249
South Dakota	58	1,350	0	0	1,408
Tennessee	10,490	4,581	6,200	1,432	22,703
Texas	26,808	12,136	0	0	38,944
Utah	2,138	2,395	0	0	4,533
Vermont	1,452	123	0	45	1,620
Virginia	3,024	536	141	1,063	4,764
Washington	5,946	4,516	0	377	10,839
West Virginia	637	5	0	0	642
Wisconsin	9,617	11,012	0	501	21,130
Wyoming	152	52	0	33	237
Pacific Northwest	0	13	0	0	13
Delaware, Maryland, N. Carolina, and Virginia	3,691	1,240	0	1,089	6,020
Florida, Georgia, and S. Carolina	4,363	255	0	0	4,618
Alabama and Tennessee	6,341	1,796	4,314	442	12,893
Kansas and Nebraska	2,066	3,241	0	1,532	6,839
Total volume	368,566	188,987	44,714	45,732	647,999
Percentage of total volume	56.9	29.2	6.9	7.0	100.0

Note: The data in this table exclude receipts at ports located in various states. Those data are presented in Table 49.

how the barge industry, through rate adjustments or other means, can attract additional business from alternate origins to offset a decrease in shipments from certain portions of the river system.

Although the total volume of grain moving by barge has increased steadily since 1977, the volume of grain traffic on the Missouri River has been more nearly stable. This stability is due in part to the fact that wheat is the most important grain in terms of volume transported on that river and the fact that a majority of this wheat is destined for hard-wheat mills located in the St. Louis area and points in the South served by barge transportation (Table 5).

Most of the grain shipped by barge moves to the various loading points along the waterways by truck. Consequently the increase in barge traffic has resulted in a corresponding increase in short-distance truck movements. Trucks are also used to haul grain to terminal elevators that load unit trains with grain for shipment to ports. Elevators that use unit trains and barges to ship grain to ports are dependent upon a continuous supply of inbound grain carried by truck. Thus trucks complement the other modes in a coordinated transportation network and have a comparative advantage in transporting grain over relatively short distances. The other modes have an advantage in hauling grain long distances.

Domestic Demand for Transportation. Although the domestic demand for grain has increased about 10 percent since 1977, this has not resulted in a corresponding increase in the demand for transportation services. A large portion of the increase in use of feed grains can be attributed to the swine industry. Because swine production is concentrated in the Midwest where large quantities of corn are grown, an expansion in the swine industry would not trigger a large increase in interstate movements of feed

Table 48. 1977 Shipments of Grain to Points of Export from Each State by Mode of Transportation

Originating state or port area	Mode of transportation			
	Rail	Truck	Barge	Total
	hundreds of tons			
States				
Alabama	36	399	979	1,414
Arizona	549	0	0	549
Arkansas	5,914	1,529	15,898	23,341
California	65	407	0	472
Colorado	1,498	100	0	1,598
Delaware	0	29	63	682
Florida	223	125	127	475
Georgia	0	60	0	60
Idaho	4,348	2,800	6,118	13,266
Illinois	38,860	9,004	185,154	233,018
Indiana	60,094	14,808	9,067	83,969
Iowa	44,966	4,041	53,219	102,226
Kansas	47,702	2,068	1,415	51,185
Kentucky	717	0	16,919	17,636
Louisiana	489	5,805	14,036	20,330
Maryland	0	2,169	19	2,188
Michigan	7,656	14,720	0	22,376
Minnesota	18,547	8,653	43,023	70,223
Mississippi	2,282	183	8,719	11,184
Missouri	8,350	5	29,086	37,441
Montana	13,298	1,283	0	14,581
Nebraska	30,366	1,170	1,238	32,774
Nevada	33	0	0	33
New Jersey	0	604	0	604
New Mexico	127	0	0	127
New York	15	305	0	320
North Carolina	623	4,727	657	6,007
North Dakota	35,886	14,223	0	50,109
Ohio	44,880	23,910	12,003	80,793
Oklahoma	26,276	3,313	2,443	32,032
Oregon	4,203	2,370	9,975	16,548
Pennsylvania	0	684	0	684
South Carolina	327	923	0	1,250
South Dakota	2,544	2,275	0	4,819
Tennessee	48	0	2,849	2,897
Texas	33,510	25,356	0	58,866
Utah	154	0	0	154
Virginia	0	507	643	1,150
Washington	18,430	2,496	27,989	48,915
Wisconsin	2,464	5,391	1,410	9,265
Wyoming	381	39	0	420
New Jersey, New York, and Pennsylvania	0	377	0	377
Delaware, Maryland, N. Carolina, and Virginia	297	430	1,534	2,261
Florida, Georgia, and S. Carolina	490	777	727	1,994
Alabama and Tennessee	1,020	529	7,958	9,507
Kansas and Nebraska	879	75	562	1,516
Port Areas				
Duluth-Superior	1,448	0	0	1,448
Chicago-Milwaukee	1,893	0	3,139	5,032
Toledo	1,189	0	0	1,189
Puget Sound	324	0	0	324
Total volume	463,401	158,669	457,559	1,079,629
Percentage of total volume	42.9	14.7	42.4	100.0

Table 49. 1977 Grain Receipts at Port Areas by Mode of Transportation

Export region and port area	Mode of transportation				Total
	Rail	Truck	Barge	Farm truck	
	hundreds of tons				
Great Lakes					
Duluth-Superior	38,659	23,649	0	0	62,308
Chicago-Milwaukee	12,306	31,931	2,134	2,719	49,090
Toledo	2,009	37,742	0	4,175	43,926
Saginaw	5	2,068	0	0	2,073
Subtotal	52,979	95,390	2,134	6,894	157,397
Atlantic					
North Atlantic	21,398	1,882	0	0	23,280
South Atlantic	101,710	10,080	3,506	2,002	117,298
Subtotal	123,108	11,962	3,506	2,002	140,578
Gulf					
East Gulf	14,538	2,210	13,987	283	31,018
Louisiana Gulf	56,315	3,413	394,015	0	453,743
North Texas Gulf	133,598	21,681	1,001	0	156,280
South Texas Gulf	23,781	12,219	0	0	36,000
Subtotal	228,232	39,523	409,003	283	677,041
Pacific					
Columbia River	33,925	10,027	44,037	0	87,989
Puget Sound	18,943	854	46	0	19,843
California	4,382	436	0	6,422	11,240
Subtotal	57,250	11,317	44,038	6,422	119,072
Total receipts	461,569	158,192	458,726	15,601	1,094,088
Percentage of total volume	42.2	14.5	41.9	1.4	100.0

Note: The data in this table include receipts from Canadian origins but exclude rail and truck shipments to Canada and Mexico that were included in Table 48.

Table 50. Barge Shipments of Grain from Each Originating Area for Shipping Seasons from 1976–77 Through 1981–82

Originating area	Shipping season[a]					
	1976–1977	1977–1978	1978–1979	1979–1980	1980–1981	1981–1982
	hundreds of tons					
Mississippi River						
Minnesota-Wisconsin	54,546	50,131	73,969	78,160	94,819	85,346
Iowa-northern Illinois	55,333	50,872	70,706	86,660	114,081	103,378
St. Louis area	51,326	53,600	47,662	42,138	50,423	43,198
Memphis area	41,086	39,977	23,924	39,822	46,360	70,893
Subtotal	202,291	194,580	216,261	246,780	305,683	302,815
Missouri River						
Nebraska-Iowa	4,289	4,096	4,380	4,909	2,876	2,023
Kansas City area	6,077	7,065	8,246	8,299	8,333	8,334
Subtotal	10,366	11,161	12,626	13,208	11,209	10,357
Illinois River	136,526	150,471	134,624	141,722	148,811	132,962
Ohio River	49,168	56,030	59,036	42,134	47,942	79,442
Snake and Columbia Rivers	35,958	37,479	43,252	46,661	57,070	59,028
Season total	434,309	449,721	465,799	490,505	570,715	584,604

Source: (*18*).

[a] The shipping season runs from April 1 of one year to March 31 of the following year.

grains. In contrast, expansion of the poultry industry has resulted in an increase in the volume of corn moving to southern states.

Export Demand for Transportation. The most important change leading to an increase in the demand for grain transportation services in recent years is the enlarged export demand. In 1977, 96.9 million tons of grain were inspected for export. By 1981, that volume had grown to 144.1 million tons, an increase of 49 percent in four years (Table 51). The volume transported by barge increased only about 13 million tons during this period (Table 50), but rail and truck movements to ports increased about 32 million tons. On the basis of modal shares revealed in the survey (Table 48), it can be estimated that railroads probably hauled about 75 percent of the increased volume.

Wheat and corn are the commodities that have dominated the increase in U.S. grain exports. Wheat exports totaled 48.4 million tons in 1981, up from 26.7 million tons in 1977. Corn exports reached a record 69.2 million tons in 1980 and then declined in 1981 following the 1980 drouth. This decline was more than offset by an increase in the wheat volume.

The volume of grain inspected at various ports in the period from 1977 through 1981 is shown in Table 52. The Gulf region continues to dominate the export market, and port elevators in that region handled 61 percent of exports in 1981. Louisiana ports are dominant on the Gulf, primarily because of the availability of barge transportation on the Mississippi River and its tributaries. The North Texas ports rank second among all port areas in volume; over 21 million tons of grain were handled by those facilities in 1981.

Perhaps the most noteworthy development since 1977 is the emergence of the Pacific area as the second most important export region. This region nearly tripled its volume

of grain exports from 9 million tons in 1977 to 26 million tons in 1981. The leading port area in that region is the Columbia River, and wheat and barley are the dominant commodities. In contrast, port facilities in the Puget Sound area handled over 7 million tons of grain in 1981, and corn and sorghum accounted for 94 percent of the total volume. Thus a rather dramatic change has occurred in grain flow patterns since 1977. The increased volume of corn and sorghum moving through these ports represents a sizable demand for rail transportation since most of this volume moves from distant origins in the northern plains and southern plains regions. Some of this grain also originates in western Iowa and Minnesota.

The volume handled by port elevators in the Atlantic region peaked at 16.6 million tons in 1979 and has since declined. Atlantic facilities draw grain from the eastern Corn Belt, and a high percentage of this grain is transported in unit trains. Perhaps the increased barge movements down the Ohio River to the Gulf region during this period contributed to the decrease in movements to Atlantic ports.

The volume and proportion of exports handled by Great Lakes elevators have declined every year since 1978 (Table 52). The reduced corn production in 1980 was no doubt an important influence in the 1981 decline. Primarily for economic reasons, the volume exported through these ports has never fulfilled the high expectations that were held when the St. Lawrence Seaway opened in 1959. Tolls for a typical bulk cargo ship moving through the St. Lawrence Seaway and Welland Canal have increased rapidly in recent years and exceeded $30,000 during the 1981 shipping season (*11*). Three other factors also limit the growth potential of the seaway: (1) it is closed during the winter because of ice, (2) draft limitations on the seaway make it necessary for large, bulk-grain tankers to partially load at Great Lakes ports and finish loading at Canadian ports along the St. Lawrence River, and (3) Great Lakes port elevators rely heavily on supplies trucked in from nearby production areas. Thus for points of origin beyond a certain distance, trucking costs become prohibitive and railroad or barge transportatio becomes competitive.

The costs of domestic transpo tation for moving grain from th point of production to U.S. por combined with the costs of ocea transportation from the port of ex port to the foreign destination wi be the most important factors i determining the share of total ex

Table 51. Volume of Grain Inspected for Export by Type of Grain, 1977 to 1981

Type of grain	Calendar year				
	1977	1978	1979	1980	1981
	millions of tons				
Wheat	26.7	37.4	36.3	39.3	48.4
Soybeans	17.8	23.1	22.7	24.0	23.3
Corn	44.2	54.8	65.4	69.2	60.5
Sorghum	6.4	5.3	6.2	8.3	8.2
Other grains[a]	1.8	0.7	2.0	3.1	3.7
Total	96.9	121.3	132.6	143.9	144.1

Source: (*18*).

[a] Includes oats, barley, rye, flaxseed, and sunflower seed.

Table 52. Volume of Grain Inspected for Export at Various Port Areas, 1977 to 1981

Export region and port area	Calendar year				
	1977	1978	1979	1980	1981
	millions of tons				
Great Lakes					
Duluth-Superior	4.0	7.3	6.9	7.3	5.8
Chicago-Milwaukee	1.8	3.1	3.9	2.1	2.2
Toledo	4.3	5.3	4.5	5.2	4.4
Saginaw	0.2	0.3	0.3	0.3	0.2
Subtotal	10.3	16.0	15.6	14.9	12.6
Atlantic					
North Atlantic	2.5	3.4	3.9	3.9	2.3
South Atlantic	10.7	11.1	12.7	11.2	12.4
Subtotal	13.2	14.5	16.6	15.1	14.7
Gulf					
East Gulf	3.0	5.5	5.1	5.4	3.7
Louisiana Gulf	42.7	47.3	50.1	56.0	60.3
North Texas Gulf	15.0	18.1	20.5	19.6	21.7
South Texas Gulf	3.4	4.8	4.6	3.0	2.2
Subtotal	64.1	75.7	80.3	84.0	87.9
Pacific					
Puget Sound	1.5	3.1	5.9	8.8	7.1
Columbia River	6.7	9.5	10.5	12.6	14.2
California	1.1	2.5	3.7	5.2	4.7
Subtotal	9.3	15.1	20.1	26.6	26.0
Interior points	0.0	0.0	0.0	3.3	2.9
Total volume	96.9	121.3	132.6	143.9	144.1

Source: (*18*).

ports handled by each port region in the future. Recent trends suggest that volumes handled by Gulf and Pacific port elevators will continue to grow as exports expand, while the volumes handled by Great Lakes and Atlantic port elevators will be maintained at current levels. In fact, current congestion at Gulf ports may encourage further expansion in shipments of corn and sorghum through Pacific ports.

Conclusions

The United States is the leading grain-producing nation in the world. Production expanded rapidly during the 1970s in response to rapidly expanding world demand. Production of feed grains, food grains, and soybeans exceeded 400 million tons in 1979, as compared to 289 million tons in 1972, the year preceding the big boom in exports.

During this period of expanding production, the amount of grain used on the farms where it is produced has remained fairly stable. Thus, the volume of grain marketed from U.S. farms increased greatly, and substantial investments were made in handling and storage facilities and in transportation equipment to meet the growing demand for marketing services. The ability of the marketing system to cope with the increased volume was aided by the construction of additional farm storage facilities. By 1978, the estimated capacity of on-farm storage facilities for grain totaled 9.9 billion bushels (*11*). These facilities enabled farmers to store their grain on the farm at harvesttime and spread marketings throughout the year.

Although on-farm storage has lessened the demands placed on commercial facilities at harvesttime, the capacity of off-farm storage facilities expanded during the 1970s to accommodate the increased volume. Between 1971 and 1981 off-farm storage capacity increased from 5.5 billion bushels to 7.1 billion bushels. Much of this expansion occurred in facilities designed to serve the growing export market: subterminals for loading unit trains, river elevators for loading barges, and port elevators for transferring grain from unit trains and barges to oceangoing bulk cargo ships.

Although the investment in handling and storage facilities was substantial, the investment in transportation equipment was even greater. The Market News Service began publishing data on barge shipments of grain in 1972, and during the first shipping season (April 1, 1972, to March 31, 1973) 29 million tons of grain were shipped by barge (*18*, April 6, 1973, p. 7). In comparison, barge shipments in 1981–82 totaled 58 million tons (see Appendix Table 6). Thus the volume shipped by barge more than doubled during this period. Perhaps the volume of grain hauled by barges would have expanded even more if physical constraints such as Lock and Dam 26 at Alton, Illinois, had not restricted growth of commerce on the Mississippi River.

The volume of grain hauled by barge is expected to continue to grow in future years. The Inland Waterways Revenue Act of 1978 authorized the construction of new locks and dams at Alton. The act also provided, however, for the imposition of an escalating fuel tax on commercial users of the shallow-draft inland waterway system. The user taxes will reduce the cost advantages enjoyed by barge lines in moving grain to Gulf ports and will probably divert some traffic to other modes. The amount of tonnage lost to railroads will depend upon the level at which these user charges are set and on the response of railroads in adjusting rates. The new locks and dam will permit larger tows of barges, reducing the costs of waiting at the locks and of breaking up tows into smaller units. Barging companies will definitely benefit from improved locks on the Mississippi River, but the absolute impact of a fuel tax is difficult to predict.

The 1970s was also a decade of change for the railroad industry. The rapidly expanding demand for rail transportation to haul grain to U.S. ports brought about a tremendous investment in covered hopper cars. The introduction of unit-train rates and widespread adoption of unit-train technology resulted in more efficient utilization of the rail-car fleet. The practice of leasing or owning grain cars also became quite common for large grain companies, and by the end of the decade the grain-hauling capacity of U.S. railroads exceeded the demand for those services.

The passage of the Staggers Act in October, 1980, partially deregulated rail rates on grain. Railroads now have the ability to change rates on short notice and to contract with shippers on long and short terms. The success and efficiency of the unit-train system for moving large quantities of grain coupled with greater freedom in setting rates has led to reductions in rates for shipping grain to various ports by multiple-car trains since the act was passed.

The Inland Waterways Revenue Act and the Staggers Act will affect the competition between modes and potentially will alter the modal shares that existed at the time of the 1977 survey. The export de-

mand for grain is expected to continue to grow in the 1980s, and all three modes of transportation should experience growth in the demand for services. The challenge will be to make the grain marketing system even more efficient in future years so that domestic users of grain will not be adversely affected by an expanding export demand. It seems that domestic users must develop facilities that will allow them to take advantage of the economics associated with trainload shipments.

The data collected through the survey represent the most comprehensive and accurate information on grain movements ever obtained. Comparing these data with the results of the 1970 survey in the South provide limited insights into how flow patterns change over time. The 1977 survey also provides an important benchmark for decisions related to federal and state transportation policies. The formulation of rational grain transportation policies depends upon a knowledge of grain flow patterns and modal shares. As the production and exports of grain continue to expand in the years ahead, additional surveys will be needed to effectively evaluate alternative policy decisions.

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Appendix Table 1. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1976–77

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	19,448.7	25,182.9	8,669.4	1,099.5	0.0	0.0	145.9	54,546.4
Iowa and northern Illinois	540.3	41,616.7	13,130.1	45.6	0.0	0.0	0.0	55,332.7
St. Louis area	13,953.9	16,548.6	19,753.2	9.8	1,033.2	0.0	26.9	51,325.6
Memphis area	11,354.1	1,937.0	27,065.1	0.0	730.0	0.0	0.0	41,086.2
Missouri River								
Nebraska-Iowa	2,333.7	1,038.5	916.5	0.0	0.0	0.0	0.0	4,288.7
Kansas City area	5,574.9	108.9	373.2	0.0	20.2	0.0	0.0	6,077.2
Illinois River	5,621.4	106,737.7	23,834.1	250.1	29.7	0.0	53.2	136,526.2
Ohio River	6,102.6	30,042.6	12,591.0	13.1	404.3	0.0	14.0	49,167.6
Snake and Columbia Rivers	34,913.1	0.0	0.0	0.0	0.0	1,045.0	0.0	35,958.1
Total volume	99,842.7	223,212.9	106,332.6	1,418.1	2,217.4	1,045.0	240.0	434,308.7

Source: (*18*, April 8, 1977).
Note: The shipping season was from April 1, 1976, to March 31, 1977.

Appendix Table 2. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1977–78

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	20,126.7	21,150.4	7,548.3	1,117.9	0.0	0.0	187.6	50,130.9
Iowa and northern Illinois	728.4	39,977.6	10,139.7	26.2	0.0	0.0	0.0	50,871.9
St. Louis area	15,683.7	17,256.7	19,635.9	35.7	988.1	0.0	0.0	53,600.1
Memphis area	12,819.3	965.2	25,456.5	0.0	735.8	0.0	0.0	39,976.8
Missouri River								
Nebraska-Iowa	1,832.4	1,376.5	733.2	142.9	10.6	0.0	0.0	4,095.6
Kansas City area	6,746.4	82.9	215.7	0.0	20.1	0.0	0.0	7,065.1
Illinois River	5,464.5	121,606.8	23,362.5	37.6	0.0	0.0	0.0	150,471.4
Ohio River	7,040.7	33,796.6	15,029.4	7.2	156.0	0.0	0.0	56,029.9
Snake and Columbia Rivers	36,999.3	0.0	0.0	0.0	0.0	480.0	0.0	37,479.3
Total volume	107,441.4	236,212.7	102,121.2	1,367.5	1,910.6	480.0	187.6	449,721.0

Source: (*18*, April 7, 1978).
Note: The shipping season was from April 1, 1977, to March 31, 1978.

Appendix Table 3. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1978–79

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	17,036.4	33,169.1	22,245.0	1,392.3	0.0	0.0	126.3	73,969.1
Iowa and northern Illinois	78.3	56,010.6	14,616.9	0.0	0.0	0.0	0.0	70,705.8
St. Louis area	9,312.9	16,313.1	21,125.4	44.6	866.3	0.0	0.0	47,662.3
Memphis area	7,255.8	272.4	15,906.9	0.0	489.4	0.0	0.0	23,924.5
Missouri River								
Nebraska-Iowa	2,440.8	774.8	1,140.0	24.3	0.0	0.0	0.0	4,379.9
Kansas City area	6,997.5	35.0	1,173.0	0.0	40.3	0.0	0.0	8,245.8
Illinois River	737.4	109,350.4	24,536.7	0.0	0.0	0.0	0.0	134,624.5
Ohio River	3,381.3	37,795.0	17,785.8	0.0	73.9	0.0	0.0	59,036.0
Snake and Columbia Rivers	42,459.6	0.0	0.0	0.0	0.0	792.7	0.0	43,252.3
Total volume	89,700.0	253,720.4	118,529.7	1,461.2	1,469.9	792.7	126.3	465,800.2

Source: (*18*, April 6, 1979).
Note: The shipping season was from April 1, 1978, to March 31, 1979.

Appendix Table 4. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1979–80

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	17,762.7	44,607.4	14,499.6	1,183.2	0.0	0.0	107.5	78,160.4
Iowa and northern Illinois	468.0	73,450.2	12,742.2	0.0	0.0	0.0	0.0	86,660.4
St. Louis area	12,471.0	12,101.3	16,638.3	0.0	927.6	0.0	0.0	42,138.2
Memphis area	10,125.0	2,133.9	27,002.7	0.0	482.4	0.0	78.4	39,822.4
Missouri River								
Nebraska-Iowa	3,081.6	964.9	862.5	0.0	0.0	0.0	0.0	4,909.0
Kansas City area	7,650.0	0.0	649.2	0.0	0.0	0.0	0.0	8,299.2
Illinois River	2,572.2	114,398.2	24,751.5	0.0	0.0	0.0	0.0	141,721.9
Ohio River	3,213.9	23,903.6	14,783.4	0.0	219.0	0.0	13.7	42,133.6
Snake and Columbia Rivers	45,106.2	0.0	0.0	0.0	0.0	1,555.0	0.0	46,661.2
Total volume	102,450.6	271,559.5	111,929.4	1,183.2	1,629.0	1,555.0	199.6	490,506.3

Source: (*18*, April 11, 1980).

Note: The shipping season was from April 1, 1979, to March 31, 1980.

Appendix Table 5. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1980–81

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	18,422.1	47,074.4	27,693.6	1,434.9	0.0	0.0	194.0	94,819.0
Iowa and northern Illinois	582.6	92,821.4	20,676.6	0.0	0.0	0.0	0.0	114,080.6
St. Louis area	20,969.1	10,795.7	16,847.1	11.5	1,786.7	0.0	13.2	50,423.3
Memphis area	20,311.5	1,545.6	23,658.9	0.0	844.2	0.0	0.0	46,360.2
Missouri River								
Nebraska-Iowa	1,395.3	861.0	529.2	90.4	0.0	0.0	0.0	2,875.9
Kansas City Area	7,962.3	0.0	370.8	0.0	0.0	0.0	0.0	8,333.1
Illinois River	4,840.5	112,534.2	31,436.1	0.0	0.0	0.0	0.0	148,810.8
Ohio River	10,181.8	15,598.8	21,704.4	0.0	420.0	0.0	137.2	47,942.2
Snake and Columbia Rivers	53,496.3	0.0	0.0	0.0	0.0	3,600.2	0.0	57,069.5
Total volume	138,034.5	281,231.1	142,916.7	1,536.8	3,050.9	3,600.2	344.4	570,714.6

Source: (*18*, April 10, 1981).

Note: The shipping season was from April 1, 1980, to March 31, 1981.

Appendix Table 6. Barge Shipments of Grain from Each Originating Area by Type of Grain, 1981–82

Originating area	Type of grain							Total volume
	Wheat	Corn	Soybeans	Oats	Sorghum	Barley	Rye	
	hundreds of tons							
Mississippi River								
Minnesota-Wisconsin	20,401.5	49,959.0	13,991.7	935.9	0.0	0.0	54.6	85,346.3
Iowa and northern Illinois	624.3	83,086.4	19,666.8	0.0	0.0	0.0	0.0	103,377.5
St. Louis area	17,570.7	8,287.8	13,644.6	0.0	3,694.9	0.0	0.0	43,197.9
Memphis area	36,473.7	812.0	30,681.3	0.0	2,925.7	0.0	0.0	70,892.7
Missouri River								
Nebraska-Iowa	479.7	370.7	1,172.4	0.0	0.0	0.0	0.0	2,022.8
Kansas City area	7,043.7	28.0	1,240.8	8.0	14.0	0.0	0.0	8,334.5
Illinois River	7,174.5	94,416.6	31,370.7	0.0	0.0	0.0	0.0	132,961.8
Ohio River	20,381.4	30,518.6	26,636.4	16.0	1,877.7	12.0	0.0	79,442.1
Snake and Columbia Rivers	53,745.0	0.0	0.0	0.0	0.0	5,282.9	0.0	59,027.9
Total volume	163,894.5	267,479.0	138,404.7	963.5	8,512.3	5,294.9	54.6	584,603.5

Source: (*18*, April 9, 1982).

Note: The shipping season was from April 1, 1981, to March 31, 1982.